Research and Development Progress Report No. 736 • October 1971
Int-OSW-RDPR-71-736

Model Studies of Outfall Systems for Desalination Plants (Part II—Estuary Models)

By W. H. Bobb, Chief, Interior Channel Section, R. A. Boland, Jr., F. A. Hermann, Jr., U. S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi, for Office of Saline Water, J. W. O'Meara, Acting Director; W. F. Savage, Assistant Director, Engineering and Development; W. W. Rinne, Chief, Special Projects Division; C. L. Gransee, Project Engineer

Contract No. 14-30-2656

United States Department of the Interior • Rogers C. B. Morton, Secretary
James R. Smith, Assistant Secretary for Water and Power Resources

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $1.50
Stock Number 2400-0696

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian Territorial affairs are other major concerns of America's "Department of Natural Resources".

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

FOREWORD

This is one of a continuing series of reports designed to present accounts of progress in saline water conversion and the economics of its application. Such data are expected to contribute to the long-range development of economical processes applicable to low-cost demineralization of sea and other saline water.

Except for minor editing, the data herein are as contained in a report submitted by the contractor. The data and conclusions given in the report are essentially those of the contractor and are not necessarily endorsed by the Department of the Interior.

PREFACE

The tests reported herein were conducted under Contract 14-30-2656 between the U. S. Department of the Interior and the U. S. Army Corps of Engineers. The study was performed in the Hydraulics Division of the U. S. Army Engineer Waterways Experiment Station during the period November 1970 to July 1971 under the direction of Messrs. E. P. Fortson, Jr., Chief of the Hydraulics Division; H. B. Simmons, Acting Chief of the Hydraulics Division; and F. A. Herrmann, Jr., Acting Chief of the Estuaries Branch. The tests were conducted by Mr. R. A. Boland, Jr., Project Engineer, and technicians of the Interior Channel Section, under the supervision of Mr. W. H. Bobb, Chief of the Interior Channel Section. This report was prepared by Messrs. Bobb and Boland with the assistance of Mr. Herrmann.

Messrs. Walter Rinne and C. L. Gransee of the Office of Saline Water, Professor R. O. Reid of Texas A&M University, and Dr. M. A. Zeitoun and Mr. W. F. McIlhenny of Dow Chemical Company visited the Waterways Experiment Station during the investigation phase of the study to observe and discuss test results.

COL Ernest D. Peixotto, CE, was Director of the Waterways Experiment Station during the conduct of the investigation and the preparation and publication of this report. Mr. F. R. Brown was Technical Director.

TABLE OF CONTENTS

CONVERSION FACTORS, BRITISH TO METRIC UNITS OF MEASUREMENT

British units of measurement used in this report can be converted to metric units as follows:

Multiply	By	To Obtain
inches	2.54	centimeters
feet	0.3048	meters
miles (U. S. statute)	1.609344	kilometers
feet per second	0.3048	meters per second
cubic feet per second	0.02831685	cubic meters per second
Fahrenheit degrees	5/9	Celsius or Kelvin degrees*
gallons (U. S.)	3.785412	cubic decimeters

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

SUMMARY

The existing comprehensive fixed-bed models of San Diego Bay, Galveston Bay, and Delaware River located at the Waterways Experiment Station were chosen to study the dispersion of heated waste brine from desalination plant outfalls. These three models were considered to be typical of estuaries on which saltwater conversion facilities are likely to be located, and it was intended that information obtained from tests in these models be readily applied to other similar estuaries. The objectives of the tests were to determine dispersion rates of the brine waste, to define the dynamic equilibrium distribution of the waste after the plant being simulated has been in operation for some time, and in the case of tests in the Delaware River model, to determine the effects of freshwater inflow on dispersion rates and equilibrium values.

Significant results of tests in the various models involving introduction of the heated effluent from a 10-mgd plant for considerable periods of time include: (a) in estuaries such as San Diego Bay, where minimal tidal current velocities exist and very little fresh water discharges into the system, the dispersion and flushing rates will be extremely slow, and the time required to reach dynamic equilibrium will be comparatively long; (b) in large, shallow estuaries such as Galveston Bay extreme care should be taken in selecting an outfall site since flow conditions in the immediate vicinity of the diffuser are highly significant in overall dispersion rates and may tend to trap the plant effluent; (c) in estuaries similar to the Delaware River, having appreciable freshwater discharge and tidal currents and a reasonably regular shape, sufficient mixing and dispersion of the effluent will probably occur after the energy of the jet leaving the diffuser is expended; and (d) the mixing and dispersion rates in estuaries similar to the Delaware River vary directly with total freshwater flow into the estuary, while the time to reach dynamic equilibrium varies inversely with total freshwater flow.

SECTION I: INTRODUCTION

Today, perhaps more so than at any time in the past, there is a growing concern with the preservation of tidal waters. Increasing industrial, municipal, and agricultural demands for available fresh water coupled with the often poor quality of return flows and heavy pollutional loadings pose serious problems to management of estuarine environments. Unrestricted waste and thermal loadings can disturb the ecological balances in tidal waters and destroy natural habitat for marine life.

Most of the major tidal water bodies along the coasts of the United States serve a multitude of uses that include recreation, sport and commercial fishing, navigation, the provision of spawning and nursery areas, and natural habitat for marine life. In many cases, these same waters also serve as the receiving water for industrial and municipal waste and for the heated water discharged from fossil- and nuclear-fueled power plants, desalination works, and other processes. The discussion that follows concerns the effluent from desalination works.

Large desalination plants to be built in the near future will employ either a variation of the multiple-effect, falling-film or multiple-stage, flash distillation processes in combination with the production of power. Such plants are most likely to be located on the shores of our oceans and estuaries where sea water would be used as the feed, and the effluents would be discharged into the marine environment.

The design of an intake-outfall system to handle the large quantity of saline water required for the operation of a dual-purpose plant involves many disciplines such as oceanography, geology, and biology as well as hydraulic and structural engineering. The problem is essentially a fluid mechanics problem involving the physical characteristics of the effluent and the receiving water. The behavior of the effluents injected into the marine environment must be studied to allow prediction of the maximum physical and chemical changes to be expected in the receiving water in the vicinity of the outfall and to develop guides for the design of an optimum outfall with respect to predetermined water-quality criteria.

At coastal locations, an obvious means of disposal of desalination plant effluents is through a properly designed outfall located offshore. When a dense effluent is discharged from one or many ports of a diffuser, it is immediately subjected to a negative buoyancy force proportional to the difference in density between the effluent and the lighter receiving water. The kinetic energy resulting from the velocity through the port is dissipated in the turbulent mixing produced by the jet, while the negative buoyancy force drives the effluent toward the sea bottom. This initial jet mixing causes a field of diluted effluent to be formed near the bottom of the receiving water, and the diluted effluent then moves with the tidal currents to be dispersed throughout the bay or estuary.

Dow Chemical Company, under contract with the Office of Saline Water,

Department of the Interior, developed conceptual designs for outfall diffusers for disposal of brine and other wastes produced by desalination plants, of various types and sizes, to be located on the banks of estuaries or on the shores of the oceans. In addition to literature and other studies to determine the effects of these wastes on environmental factors, Dow Chemical Company conducted a series of laboratory experiments and formulated mathematical models to define the characteristics of an emerging jet of greater density than the receiving water. Both Dow Chemical Company and the Office of Saline Water believed that the conceptual designs developed under the contract should be subjected to hydraulic model testing before being recommended for field installation.

The hydraulic model study reported herein involved modeling the entire diffuser system and testing it under conditions that would be encountered at various probable plant locations. The variables to be investigated included depth and slope of the receiving water bottom, presence of thermal and/or salinity stratification in the receiving water, alongshore or tidal currents that would increase dispersion of the wastes, freshwater inflow into the estuary, and other factors. In connection with this study hydraulic models were useful in two principal areas. The first was concerned with the design of diffusers to ensure optimum initial mixing of the waste with the receiving water in the near field. The second was concerned with the effects of the waste on environmental factors (dispersion, flushing, and salinity concentrations) in the far field in coastal waters or estuaries and will be referred to as the estuary model dispersion studies. Only the dispersion studies in estuary models will be discussed in the remainder of this report. The diffuser design studies are discussed in Part I of this report under separate cover.

Of the several comprehensive models at the U. S. Army Engineer Waterways Experiment Station, it was decided that the dispersion studies should be made in the San Diego Bay, Galveston Bay, and Delaware River models. These three models were typical of the estuaries on which saltwater conversion facilities are likely to be located; and it was believed that information obtained from tests in these models could be readily applied to other estuaries. The objectives of the tests were to determine dispersion rates of the brine waste and to define the dynamic equilibrium distribution of the waste after the plant being simulated had been in operation for some time.

SECTION II: SAN DIEGO BAY MODEL

A. Description

The first dispersion study was conducted in the existing comprehensive model of San Diego Bay, the limits of which are shown in plate 1. The model was constructed of concrete to linear scale ratios, model to prototype, of 1:500 horizontally and 1:100 vertically. Other scale ratios, computed from the linear scales, were: velocity 1:10, time 1:50, discharge 1:500,000, and volume 1:25,000,000. Both the temperature and salinity scale ratios were 1:1. However, since the waters within the bay and adjacent ocean areas are essentially homogeneous, it was not necessary to use salt water in the model to reproduce prototype conditions of tides, currents, flow patterns, and dispersion characteristics; therefore, fresh water was used for the ocean supply. One prototype diurnal tidal cycle of 24 hr and 50 min was reproduced in the model in 29 min and 48.5 sec.

B. Test Procedure

The dispersion test involved simulation of an average size plant designed to produce 10 million gallons* per day (mgd) of fresh water. A typical profile of the outfall line and diffuser for a coastal rather than estuarine installation is shown in fig. 1, and the specifications of the 10-mgd plant are given below along with the model equivalents:

	Prototype	Model
Mixed effluent flow rate	21.23 mgd	42.46 gpd
Δt of effluent, ^{o}F	20	20
Difference between effluent and receiving water salinities, ppt	11.4	11.4
Diffuser length, ft	195	0.39
Diffuser diameter, in.	30	0.30
Diffuser ports:		
Number	16	16
Spacing, ft	13	0.026
Diameter, in.	6	3/64

The diffuser was located approximately 4000 ft offshore from the San Diego Power Plant as shown in plate 1. The depth of water at the diffuser site was about 11 ft referred to mean sea level (msl). In the model, the diffuser port size was adjusted to obtain a plume height and shape approximating the height and shape of the plume observed in the flume tests.

---

* A table of factors for converting British units of measurement to metric units is presented on page v.

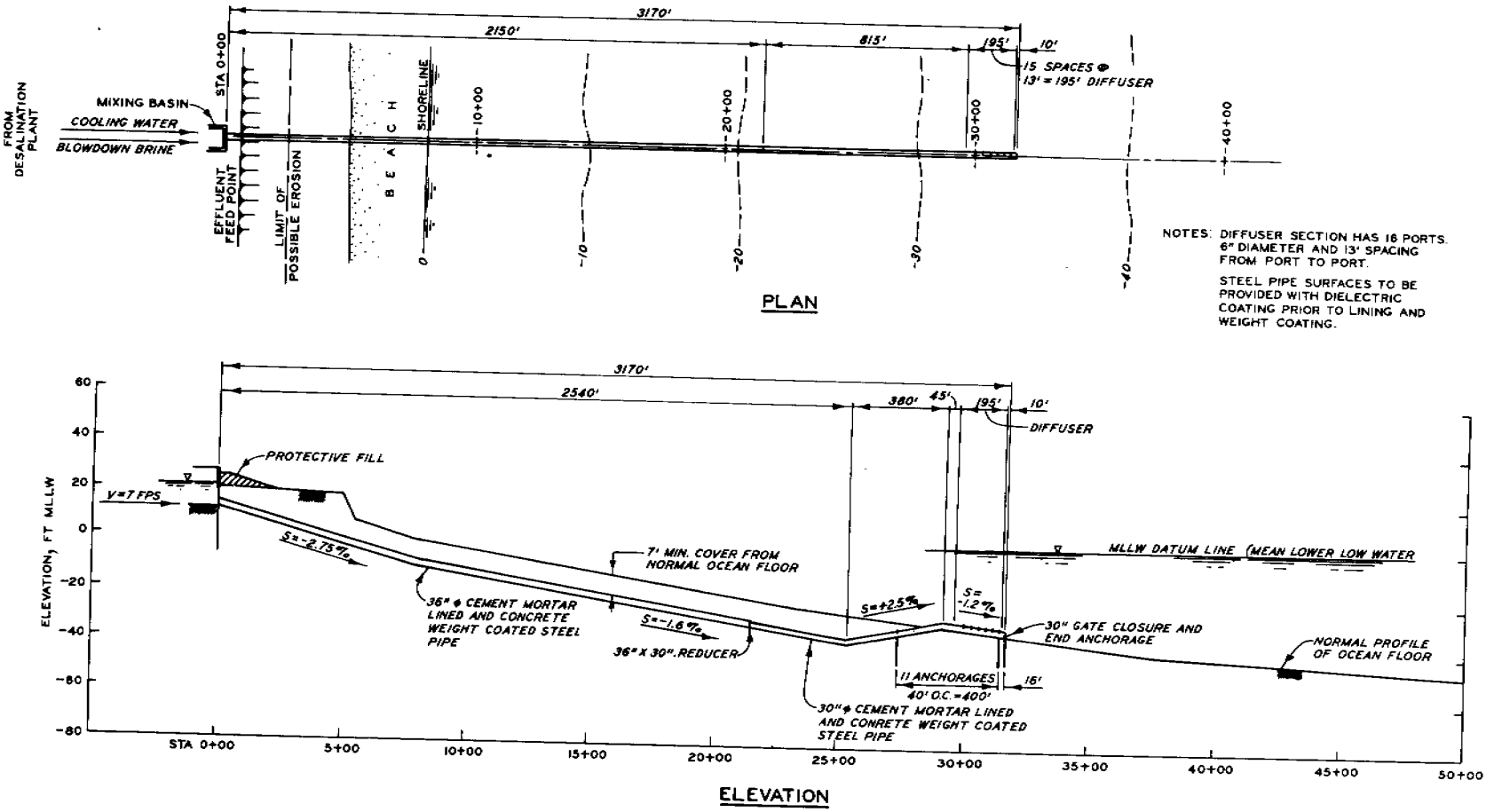


Fig. 1. Plan and profile of typical outfall-diffuser, 10-mgd plant

Because there are no significant salinity gradients in San Diego Bay, it was unnecessary to reproduce the ocean and bay salinity in the model. Thus, the salinity of the brine effluent in the model was adjusted to the difference in concentration between the prototype effluent and the receiving water. The brine concentration in the model was 11.4 parts per thousand (ppt)(45.4 ppt effluent salinity minus 34.0 ppt bay salinity), instead of 45.4 ppt as would be the case in the prototype. Use of the lower model brine salinity was possible because the difference in density between the brine and the receiving water, rather than their absolute densities, was the pertinent parameter in the dispersion process. A fluorescent dye was added to the model brine to observe dispersion of the brine during the test. The concentrations of both salt and dye in all water samples were measured to determine if the dye and salinity dispersion could be correlated to facilitate analysis of samples obtained in later tests in other models where salt water was used for the ocean supply.

After establishing conditions of dynamic hydraulic stability in the model, the dyed brine was heated to a temperature 20°F above that of the receiving water to reproduce the temperature-induced density difference in addition to the salinity-induced density difference. The heated brine was then discharged into the model at a uniform rate through the diffuser for 60 tidal cycles, or for about 30 hours actual time. About 53 gal of brine solution was introduced into the model during the test.

Salinity and dye concentration measurements were made of water samples obtained from surface and bottom depths every other tidal cycle at the times of local high- and low-water slack of the tidal current at all stations shown in plate 1. The purpose of these observations was to determine the dispersion rates of the brine waste throughout the bay and to define when the dynamic equilibrium distribution of the waste was established after the plant being simulated had been in continuous operation for some time. Water samples were withdrawn from the model manually with 10-cc pipettes and transferred to 5-cc vials that were immediately closed with rubber stoppers. Dye concentrations were subsequently determined by use of fluorometers, and salinities were then determined by conductivity cells specially built and calibrated for this purpose. The dye concentration data were compared with corresponding salinity measurements to check the correlation between the dispersion characteristics of the fluorescent dye and those of the saline effluent, since it is intended to use dye to determine dispersion patterns of the brine solution in future studies in the two other estuary models. It was concluded that within the range of salinity changes anticipated in the other studies resulting from the addition of the plant effluent to the saline receiving water the dye movement would accurately indicate the dispersion characteristics of the effluent.

During this test, a mean tide having a diurnal range (higher-high water to lower-low water) of 6.2 ft at the Ballast Point gage in the bay entrance was reproduced in the model. Plates 2 and 3 show tidal data taken during the test, while plates 4-7 show current velocities at a number of stations in the bay. There was no freshwater inflow to the bay.

C. Test Results

The salinity concentration of each sample was determined in parts per thousand, total salt, and subsequently converted to a percentage of the initial difference between the effluent and receiving water salinities (11.4 ppt). Plots of these percentages, with respect to time in tidal cycles after the effluent injection was started, were prepared for each observation station by plotting the values on semilog paper and drawing a smooth, best-fit curve (plates 8-37). The curves show the arrival time and dispersion rate of the brine waste, define the dynamic equilibrium value of the waste, and show when equilibrium was obtained at both surface and bottom depths. Tabulations of the model data used to construct these plots are presented in Appendix A to this report under separate cover. Plates 38-41 are contour maps showing lines of equal percentages of initial salinity concentration at the surface and bottom at the times of local high- and low-water slack after reaching the dynamic equilibrium distribution of the effluent throughout the bay.

D. Discussion of Results

The maximum salinity increase detected at the bottom was about 8 percent of the initial salinity difference at the diffuser; and this value extended downstream from the diffuser for about 6000 ft at low-water slack and about 4000 ft at high-water slack as shown in plates 41 and 39, respectively. The maximum salinity increase detected at the surface was about 3 percent within an area about 800 ft long downstream from the diffuser at low-water slack.and about 3000 ft long at high-water slack. Apparently the dynamic equilibrium distribution of the effluent was achieved about 30 to 50 cycles after injection of the effluent was initiated, depending on the distance from the diffuser. The grouping of the contours around the diffuser in both plates 39 and 41 indicates that although the salinities were not greatly increased (8 percent of 11.4 ppt is only 0.9 ppt) by the addition of the brine effluent to the system the flushing rate in this type of estuary is extremely slow. This characteristic would be a significant factor in evaluating this site for the location of a desalination plant outfall.

SECTION III: GALVESTON BAY MODEL

A. Description

The second dispersion study was conducted in the existing comprehensive model of the Galveston Bay complex, the limits of which are shown in plate 42. The model was constructed of concrete to linear scale ratios, model to prototype, of 1:600 horizontally and 1:60 vertically. Other scale ratios, computed from the linear scales, were: velocity 1:7.75, time 1:77.46, discharge 1:278,855, and volume 1:21,600,000. One prototype diurnal tidal cycle of 24 hr and 50 min was reproduced in the model in 19 min and 14.4 sec. Both the temperature and salinity scale ratios were 1:1.

B. Test Procedure

The dispersion test involved simulation of the same prototype 10-mgd plant simulated in the San Diego Bay model, and the specifications are repeated below along with the model equivalents determined by the scales of the Galveston Bay model.

	Prototype	Model
Mixed effluent flow rate	21.23 mgd	76.13 gpd
Δt of effluent, ^{o}F	20	20
Difference between effluent and receiving water salinities, ppt	11.4	11.4
Diffuser length, ft	195	0.33
Diffuser diameter, in.	30	0.50
Diffuser ports:		
Number	16	16
Spacing, ft	13	0.0217
Diameter, in.	6	3/32

The diffuser was located approximately 5000 ft offshore from the P. H. Robinson Power Plant discharge structure as shown in plate 42. The depth of water at the diffuser was about 12 ft msl. The diffuser port size was adjusted to obtain a plume height and shape approximating the height and shape obtained in the flume tests. Because of the necessity to introduce salt water in the model to properly reproduce prototype conditions of tides, currents, flow patterns, and dispersion characteristics, the concentration of the brine effluent was treated differently than in the preceding model test. The average salinity over a tidal cycle at the diffuser site was found to be 19.6 ppt in the model. The required effluent concentration was 11.4 ppt greater than the average salinity of the receiving water and was thus adjusted to 31.0 ppt. A fluorescent dye was added to the effluent to indirectly determine dispersion of the brine during the test. This method was used rather than direct observation of salinity

because it is difficult to accurately measure small salinity differentials at high absolute salinities. Since the San Diego Bay test indicated that a direct correlation exists between dye and salinity dispersion, only the dye concentrations of the water samples were measured for the Galveston Bay model test. The dye concentrations were converted to a percentage of the initial salinity difference between the effluent salinity and the average receiving water salinity rather than to a percentage of the absolute salinity concentration, because the salinity (or density) difference is the pertinent parameter in the dispersion process.

After establishing conditions of dynamic hydraulic and salinity stability in the model, the brine was heated to a temperature 20°F above that of the receiving water to reproduce the temperature-induced density difference. The heated brine was then discharged into the model through the diffuser, which was embedded in the concrete model bottom, for 78 tidal cycles or for about 26 hours actual time. About 88 gal of brine solution was introduced into the model during the course of the test.

Dye concentration measurements were made of water samples obtained from surface and bottom depths every other tidal cycle at the times of local high- and low-water slack of the tidal current at all stations shown in plate 42. The purpose of the observations, as in the preceding test, was to determine the dispersion rates of the brine waste and define when equilibrium distribution of the waste was obtained with the plant being simulated in continuous operation. Samples were withdrawn from the model manually with 10-cc pipettes and transferred to 5-cc vials. Dye concentrations were determined by use of fluorometers.

During this test, a mean tide with a range of 2.1 ft at the Pleasure Pier gage (Galveston) was reproduced in the model. Plate 43 shows tidal data taken during the test at three bay stations and at Pleasure Pier, the tide control station for the Gulf. Total freshwater inflow to the bay from the various inflow points shown in plate 42 was 11,929 cfs and represented a mean discharge. Gulf salinity was 32.5 ppt.

C. Test Results

The dye concentration of each sample was determined in parts per billion (ppb), and subsequently converted to a percentage of the initial difference between the effluent and receiving water salinities (11.4 ppt). Plots of these percentages, as a function of time in tidal cycles after the effluent injection started, were prepared for each observation station by plotting the values on semilog paper and drawing smooth, best-fit curves (plates 44-87). Tabulations of the model data used to construct these plots are presented in Appendix A to this report under separate cover. Plates 88 and 89 are contour maps showing lines of equal percent of initial salinity difference (11.4 ppt) at the surface and bottom at the times of local high- and low-water slack and define the approximate dynamic equilibrium distribution of the effluent throughout the bay.

D. Discussion of Results

The maximum salinity increase detected at the bottom was about 13 percent of the initial salinity difference at the diffuser for a distance of about 2000 ft downstream from the diffuser at the times of both high- and low-water slack. A salinity increase of about 10 percent of the initial salinity difference was detected at the bottom 9000 ft downstream of the diffuser at the time of low-water slack, and this distance was reduced to 6000 ft by the time of high-water slack. The maximum increase detected at the surface was about 1 percent for a distance of about 5000 ft downstream from the diffuser at low-water slack and about 2 percent for a distance of about 4000 ft at high-water slack. Apparently the dynamic equilibrium distribution of the effluent was achieved in about 20 to 50 cycles after injection of the effluent was initiated, depending on the distance from the diffuser. Maximum current velocities in the vicinity of the diffuser are about 0.5 fps; consequently, little mixing or dispersion occurs after the energy of the jet leaving the diffuser is expended. The effluent rises from 5 to 7 ft above the bottom immediately upon leaving the diffuser, settles back to the bottom in a thin layer as a result of the density gradient, and subsequently slowly spreads over the model bottom as a result of the tidal action. Although tide and salinity conditions at this site are considerably different from those at the site investigated in the San Diego Bay model, flushing characteristics in these two areas are similar. Bays of this type are not considered to be good locations for releasing wastes from desalination plants.

SECTION IV: DELAWARE RIVER MODEL

A. Description

Three additional dispersion studies were conducted in the existing comprehensive model of the Delaware River estuary, the limits of which are shown in plate 90. The model was constructed of concrete to linear scale ratios, model to prototype, of 1:1000 horizontally and 1:100 vertically. Other scale ratios, computed from the linear scales, were: velocity 1:10, time 1:100, discharge 1:1,000,000, and volume 1:100,000,000. One prototype tidal cycle of 12 hr and 25 min was reproduced in the model in 7 min and 27 sec. Both the temperature and salinity scale ratios were 1:1.

B. Test Procedure

Since the freshwater inflow to the Delaware estuary varies over much wider limits than that for the other two estuaries studied in this investigation, it was decided that tests in this model should be made for conditions of low, mean, and high freshwater inflows to determine inflow effects on dispersion patterns and rates. The dispersion tests involved simulation of the same prototype 10-mgd plant simulated in the other two models, and the specifications are repeated below along with the model equivalents determined by the scales of the Delaware River model.

	Prototype	Model
Mixed effluent flow rate	21.23 mgd	21.23 gpd
Δt of effluent, ^{o}F	20	20
Difference between effluent and receiving water salinities, ppt	11.4	11.4
Diffuser diameter, in.	30	0.30
Diffuser ports:		
Number	16	16
Spacing, ft	13	0.013
Diameter, in.	6	3/64

The diffuser was located in a depth of about 18 ft referred to local mean low water, approximately 5000 ft offshore, and approximately perpendicular to channel station 365 (see plate 90). Because of the necessity to introduce salt water in the Delaware River model to properly reproduce prototype conditions of tides, currents, flow patterns, and dispersion characteristics (as in the Galveston Bay model test), the brine effluent concentration in the model was the same as it would be in nature. The average salinities over a tidal cycle at the diffuser site for low, mean, and high freshwater inflow conditions were found to be 21.0, 17.6, and 11.0 ppt, respectively. The required effluent concentration was again 11.4 ppt greater than that of the receiving water; therefore, the effluent concentrations for the three inflow conditions were adjusted to 32.4, 29.0, and

22.4 ppt for the low, mean, and high inflow tests, respectively. A fluorescent dye was added to the effluent to indirectly observe dispersion of the brine as in the Galveston Bay test. Since the San Diego Bay test indicated that a direct correlation exists between dye and salinity dispersion, only dye concentrations were measured for each sample taken during the Delaware River model tests. The dye concentrations were converted to a percentage of the initial difference between the effluent salinity and the average receiving water salinity rather than a percentage of absolute salinity concentration, because the salinity (or density) difference is the pertinent parameter in the dispersion process.

After establishing conditions of dynamic hydraulic and salinity stability in the model for each of the three river flows, the brine was heated to a temperature 20°F above that of the receiving water to reproduce the temperature-induced density difference. The heated brine was then discharged into the model through the diffuser for 60 tidal cycles, or for about 8 hours actual time. About 7 gal of the brine solution was introduced into the model during the course of each test.

Dye concentration measurements were made of water samples obtained from surface and bottom depths every other tidal cycle at times of local high- and low-water slack of the tidal current at all stations shown in plate 91. The purpose of the observations, as in the preceding tests, was to determine dispersion rates of the brine waste and define when equilibrium distribution of the waste was obtained with the plant being simulated in continuous operation. Samples were withdrawn from the model manually with 10-cc pipettes and transferred to 5-cc vials. Dye concentrations were determined by use of fluorometers.

During these tests, a mean tide with a range of 5.5 ft at the Miah Maull gage in Delaware Bay was reproduced in the model. Total freshwater inflows to the estuary from the various freshwater inflow points shown in plate 89 were 6542, 20,200 and 60,600 cfs for the low, mean, and high freshwater flow tests, respectively. Source salinity at the Capes was 31.0 ppt.

Tidal measurements made throughout the model for mean conditions of tide and freshwater inflow are shown in plate 92. The range of tide is shown in the top plot, mean tide level is shown in the middle plot, and high- and low-water slack times are shown in the bottom plot. These phenomena were not changed significantly in the vicinity of the diffuser for low- and high-flow conditions.

C. Low-Flow Test Results

The dye concentration of each sample was determined in parts per billion, and subsequently converted to a percentage of the initial difference between the effluent and the average receiving water salinities (11.4 ppt). Plots of these percentages, as a function of time in tidal cycles after effluent injection started, were prepared for each observation station by

plotting the values on semilog paper and drawing a smooth, best-fit curve (see plates 93-124). Tabulations of the model data used to construct these plots are presented in Appendix A to this report under separate cover. Plates 125-128 are contour maps showing lines of equal percent of initial salinity difference (11.4 ppt) at the surface and bottom at the times of local high- and low-water slack of the tidal current and define the dynamic equilibrium distribution of the effluent throughout the estuary.

D. Discussion of Low-Flow Test Results

After 60 tidal cycles of simulation of continuous plant operation, the plant effluent had spread throughout a major portion of Delaware Bay. The effluent had been carried upstream to beyond Artificial Island and downstream to within 5 miles of the Capes. The dispersion was excellent, and salinity increases are considered minimal. The maximum salinity increase detected at the bottom during the low-flow test was about 0.30 percent of initial salinity difference at the diffuser, and this value was found in an area about 500 ft wide and 25,000 ft long in a downstream direction from the diffuser at the time of low-water slack as shown in plate 128. This represents a maximum increase in salinity concentration in that area of only 0.03 ppt (11.4 ppt × 0.30 percent). Maximum current velocities in the vicinity of the diffuser are about 2.2 fps, and the flow is quite turbulent; consequently, a considerable amount of mixing or diffusion occurs after the energy of the jet leaving the diffuser is expended. Maximum salinity increases at surface and bottom at high-water slack and at the surface at low-water slack were about 0.02 ppt and were confined to generally small areas in the immediate vicinity of the diffuser. Apparently the dynamic equilibrium distribution of the effluent was achieved in about 30-50 cycles after injection of the effluent was initiated, depending on the distance from the diffuser.

E. Mean-Flow Test Results

As in the preceding test, the dye concentration of each sample was determined in parts per billion and subsequently converted to a percentage of the initial difference between the effluent and receiving water salinities (11.4 ppt). Plots of these percentages, as a function of time in tidal cycles after effluent injection started, were prepared for each observation station by plotting the values on semilog paper and drawing a smooth, best-fit curve (see plates 129-156). Tabulations of the model data used to construct the above plots are presented in Appendix A to this report under separate cover. Plates 157-160 are contour maps showing lines of equal percent of initial salinity difference (11.4 ppt) at the surface and bottom at the times of local high- and low-water slack of the tidal current and define the dynamic equilibrium distribution of the effluent throughout the estuary.

F. Discussion of Mean-Flow Test Results

The maximum salinity increase detected during the mean-flow test was about 0.30 percent of the initial salinity difference (11.4 ppt), and this

value was found in an area at the bottom about 15,000 ft long and 500 ft wide extending in a downstream direction from the diffuser at the time of low-water slack. This represents a maximum increase in salinity concentration in that area of about 0.03 ppt (11.4 ppt × 0.30 percent). Comparison of the contours of salinity increase presented in plates 160 and 128 indicates a definite correlation between river discharge and dispersion of the effluent. As the river discharge increases, the mixing or dispersion rate increases. Thus, the area within each corresponding contour line is less for mean flow than for low flow. Apparently the dynamic equilibrium distribution of the effluent was achieved in about 20-40 cycles after injection of the effluent was initiated, depending on the distance from the diffuser.

G. High-Flow Test Results

As in the preceding tests, the dye concentration of each sample was determined in parts per billion, and subsequently converted to a percentage of the initial difference between the effluent and the receiving water salinities (11.4 ppt). Plots of these percentages, as a function of time in tidal cycles after effluent injection started, were prepared for each observation station where dye was detected by plotting the values on semilog paper and drawing a smooth; best-fit curve (see plates 161-167). The model data used to construct the above plots are tabulated in Appendix A to this report under separate cover.

H. Discussion of High-Flow Test Results

The maximum salinity increase detected during the high-flow test was about 0.16 percent of the initial salinity difference (11.4 ppt) and was found in a comparatively small area on the bottom about 3000 ft long in a downstream direction from the diffuser (station D2) at the time of low-water slack, as shown in plate 168. This represents a maximum increase in salinity concentration in that area of about 0.02 ppt (11.4 ppt × 0.16 percent). At bottom depth at high-water slack, significant concentrations of dye extended only 6000 ft upstream (sta U2) and 10,000 ft downstream (sta D3) from the diffuser, as shown in plate 169. Maximum observations were only about 0.09 percent of the initial salinity difference (11.4 ppt). As in the case of the mean-flow test, dispersion of the effluent was increased with increasing freshwater inflow. Apparently the dynamic equilibrium distribution of the effluent was achieved in about 10-30 cycles after effluent injection was initiated, depending on the distance from the diffuser.

SECTION V: CONCLUSIONS

Based on the results of model tests of a 10-mgd desalination plant reported herein, the following conclusions have been reached:

1. Test results for the plant outfall located in the San Diego Bay model indicated that for an estuary similar to San Diego Bay where minimal tidal current velocities exist and very little fresh water discharges into the system the dispersion and flushing rates will be extremely slow. Even though the dispersion rate in such a system will be quite slow, the maximum salinity increase to be expected will probably be about 1 to 2 ppt close to the outfall. These characteristics would be significant factors in evaluating the potential effects of desalination plants located on estuaries of this type.

2. The results of the tests in the Galveston Bay model indicated that care should be taken in selecting an outfall site. Velocities in the vicinity of the proposed site should be great enough to generate sufficient mixing or dispersion after the energy of the jet leaving the diffuser is expended. The site investigated in the Galveston Bay model is not considered to be a good location for releasing the waste from a desalination plant because of the low velocities at the diffuser location, even though there is a significant freshwater inflow to the bay. Wind-induced mass circulation phenomena can be significant in a broad, shallow bay (like Galveston Bay) subject to appreciable and essentially constant winds. This factor was not included in the model investigation but should be considered in any proposed site investigation.

3. The results of tests in the Delaware River model indicated that in an estuary of this type (having appreciable freshwater discharge, relatively strong tidal current velocities, and a reasonably regular shape) sufficient mixing and dispersion of the effluent will probably occur after the energy of the jet leaving the diffuser is expended. The freshwater discharge and tidal currents generate high turbulence (thus mixing) throughout the system, and the regular shape reduces the possibility of "dead water" which can develop in side embayments, etc.

4. The results of tests in the Delaware River model also showed, as would be expected, that the mixing or dispersion rate in this type of system is directly related to the river discharge. As the river discharge increases, the mixing or dispersion rate also increases.

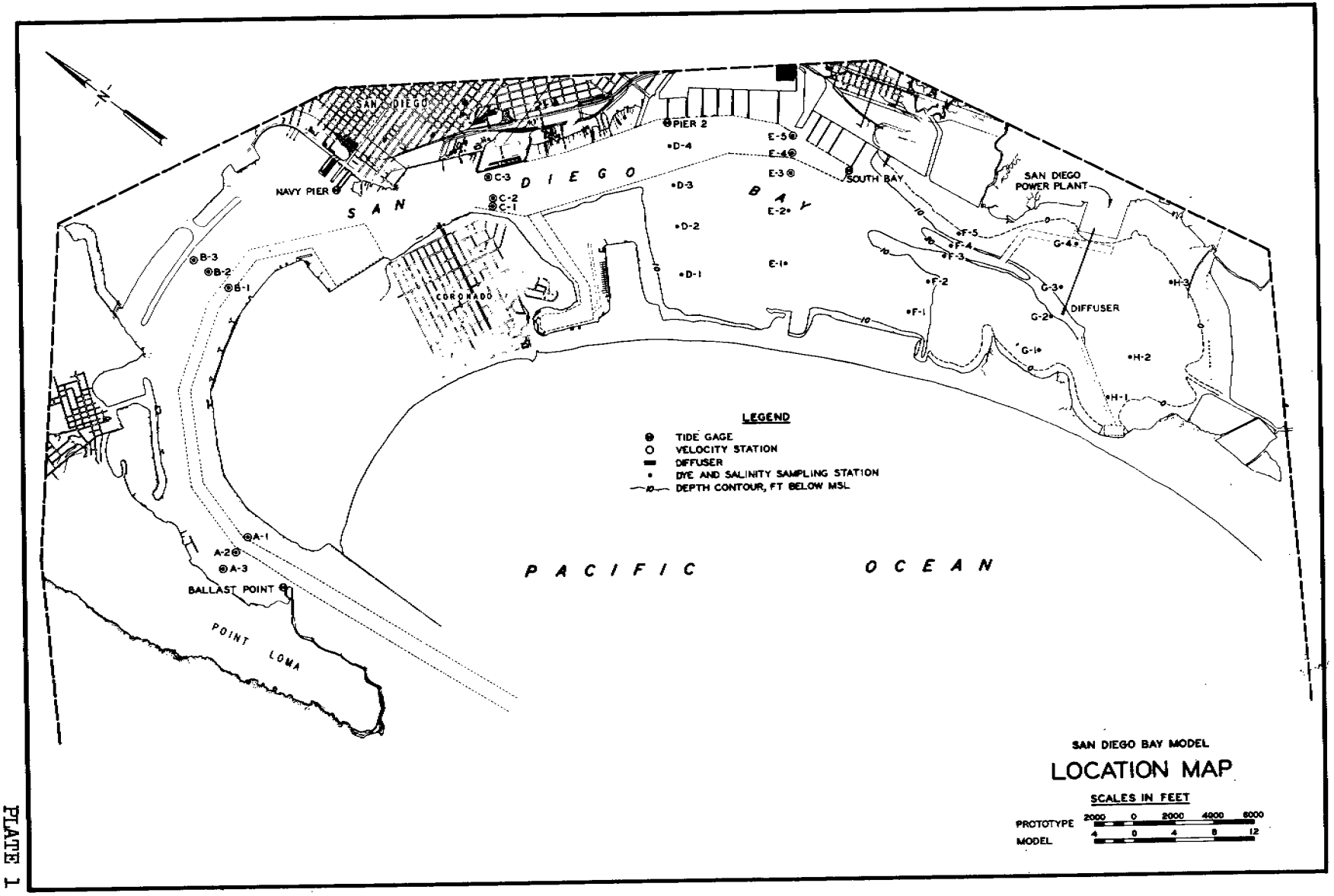
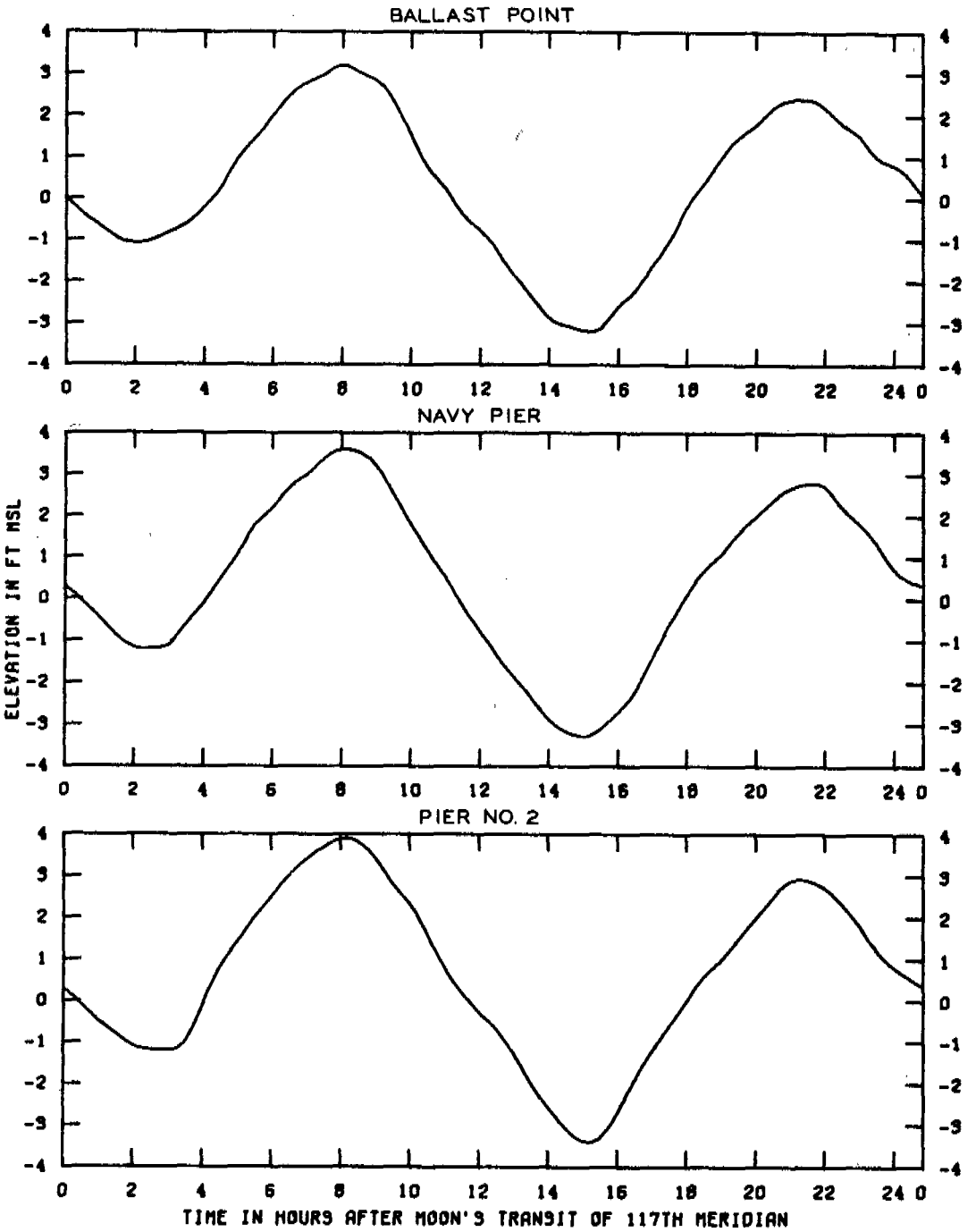

SAN DIEGO
PIER 2
NAVY PIER
C-3
C-2
C-1
D-4
D-3
D-2
D-1
E-5
E-4
E-3
E-2
E-1
SOUTH BAY
SAN DIEGO POWER PLANT
F-5
F-4
F-3
F-2
F-1
G-4
G-3
G-2
G-1
H-3
H-2
H-1
DIFFUSER
B-3
B-2
B-1
CORONADO
A-1
A-2
A-3
BALLAST POINT
POINT LOMA
SAN DIEGO BAY
PACIFIC OCEAN
LEGEND
TIDE GAGE
VELOCITY STATION
DIFFUSER
DYE AND SALINITY SAMPLING STATION
DEPTH CONTOUR, FT BELOW MSL
SAN DIEGO BAY MODEL
LOCATION MAP
SCALES IN FEET
PROTOTYPE 2000 0 2000 4000 6000
MODEL 4 0 4 8 12

PLATE 1



TEST CONDITIONS

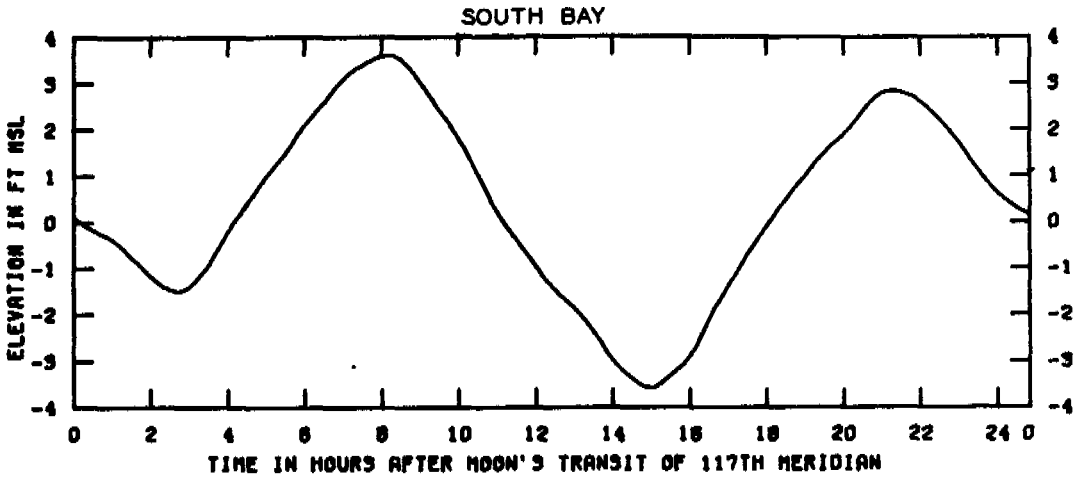
TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT

SAN DIEGO MODEL

TIDAL OBSERVATIONS

STATIONS: BALLAST POINT, NAVY PIER, AND PIER NO. 2

PLATE 2



TEST CONDITIONS

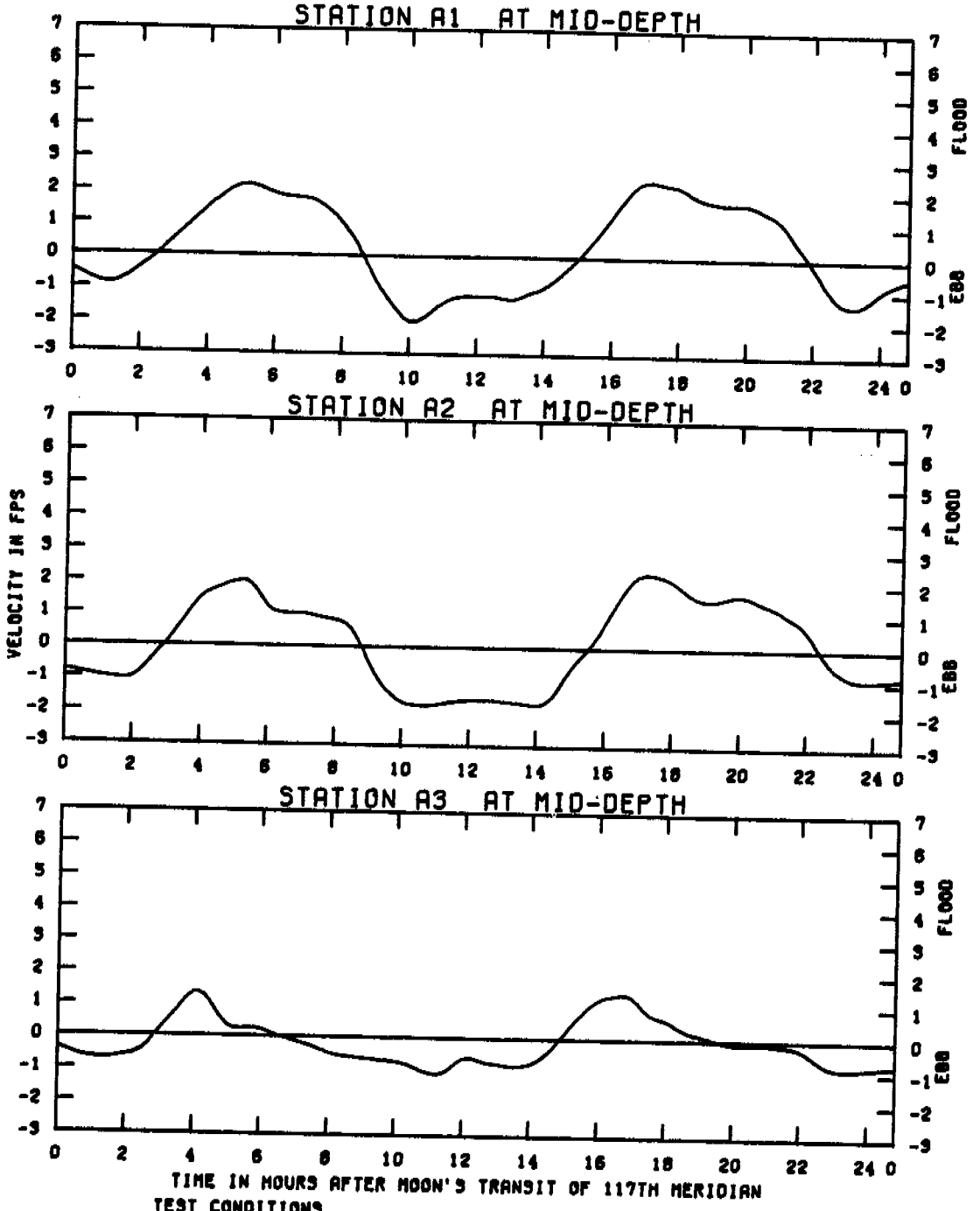
TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT

SAN DIEGO MODEL

TIDAL OBSERVATIONS

STATION: SOUTH BAY

PLATE 3



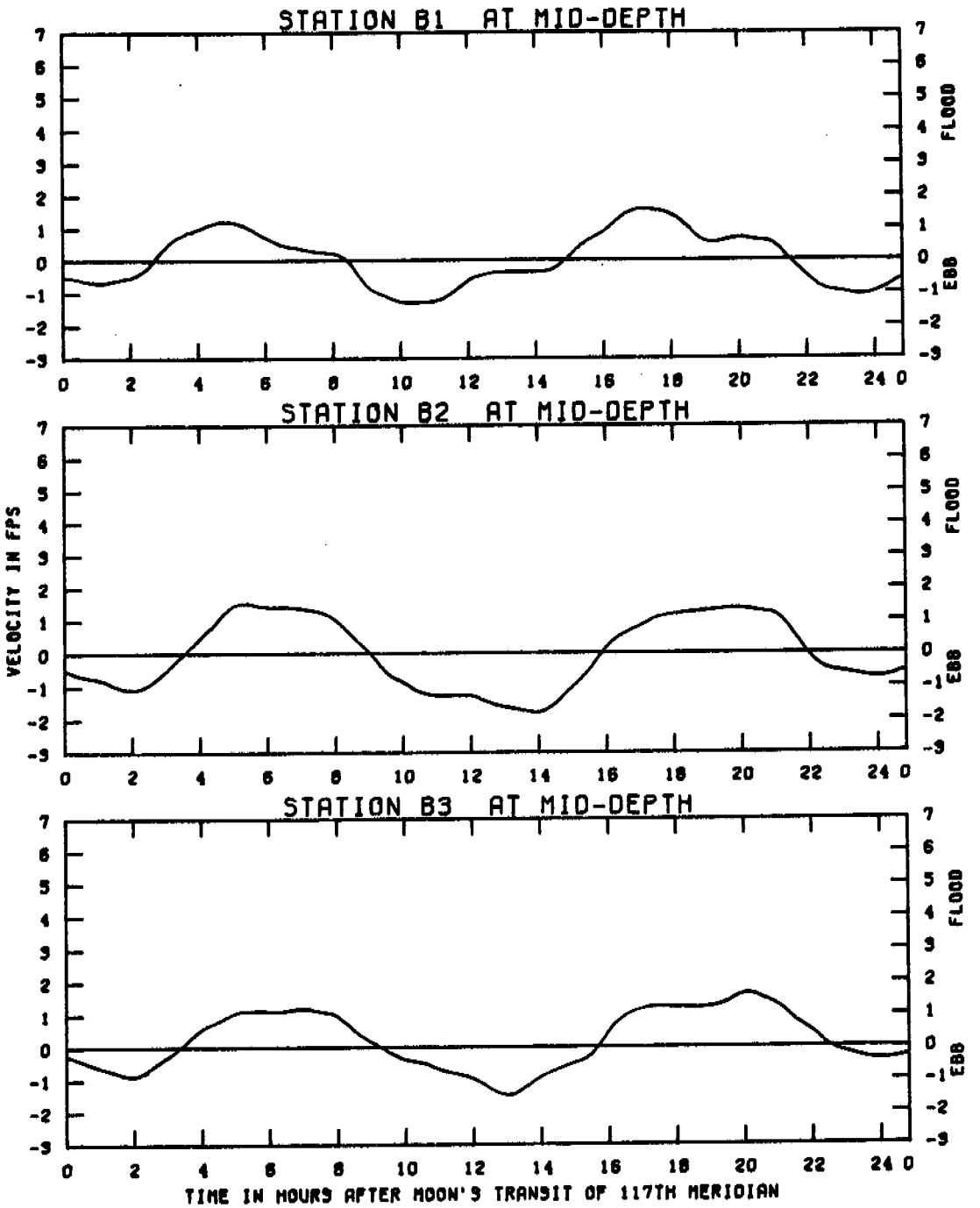
TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT	SAN DIEGO MODEL
OCEAN SALINITY (TOTAL SALT)	0.0 PPT	

VELOCITY OBSERVATIONS

STATIONS
A1 , A2 , AND A3

PLATE 4



TEST CONDITIONS

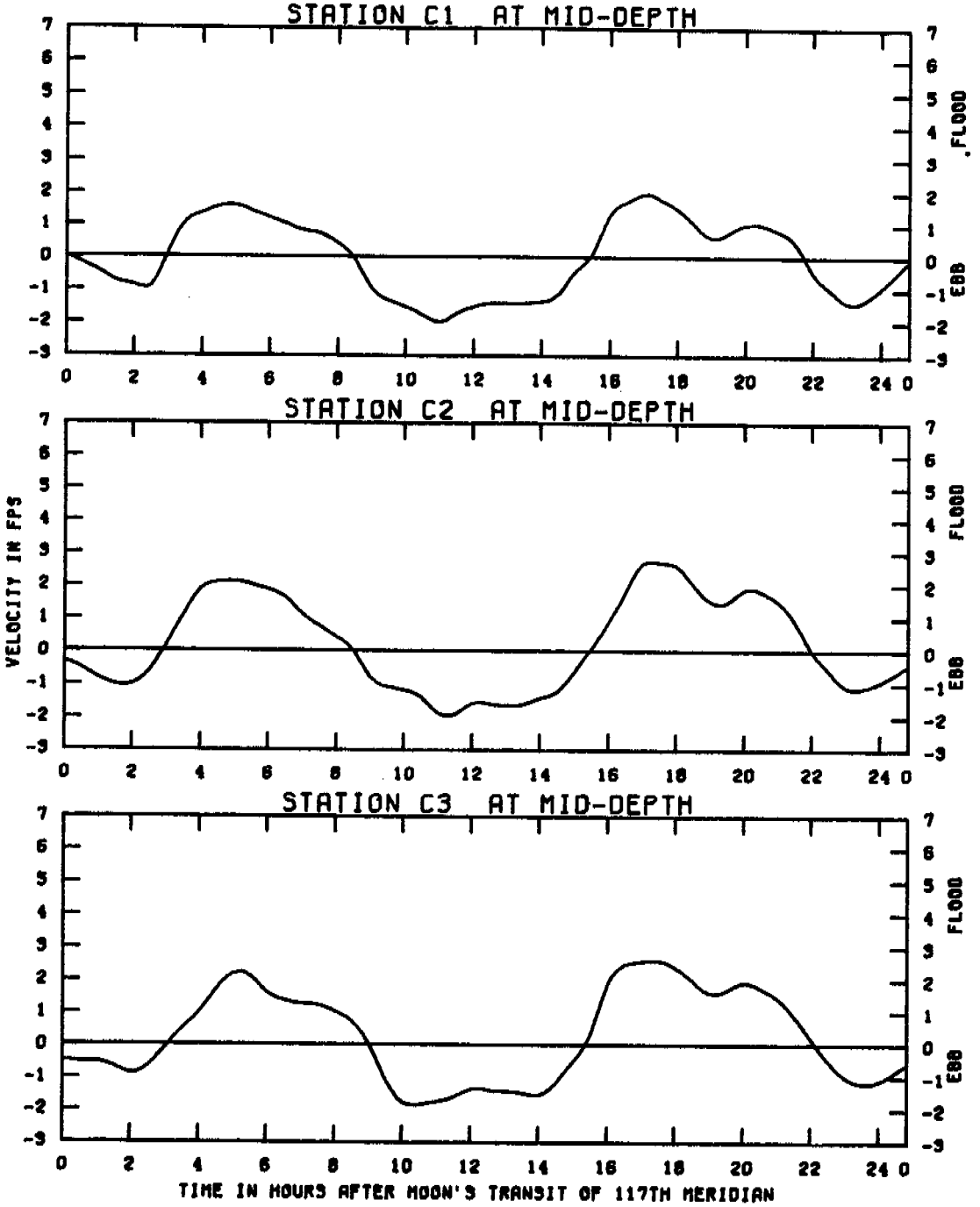
TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT

SAN DIEGO MODEL

VELOCITY OBSERVATIONS

STATIONS
B1 , B2 , AND B3

PLATE 5



TEST CONDITIONS

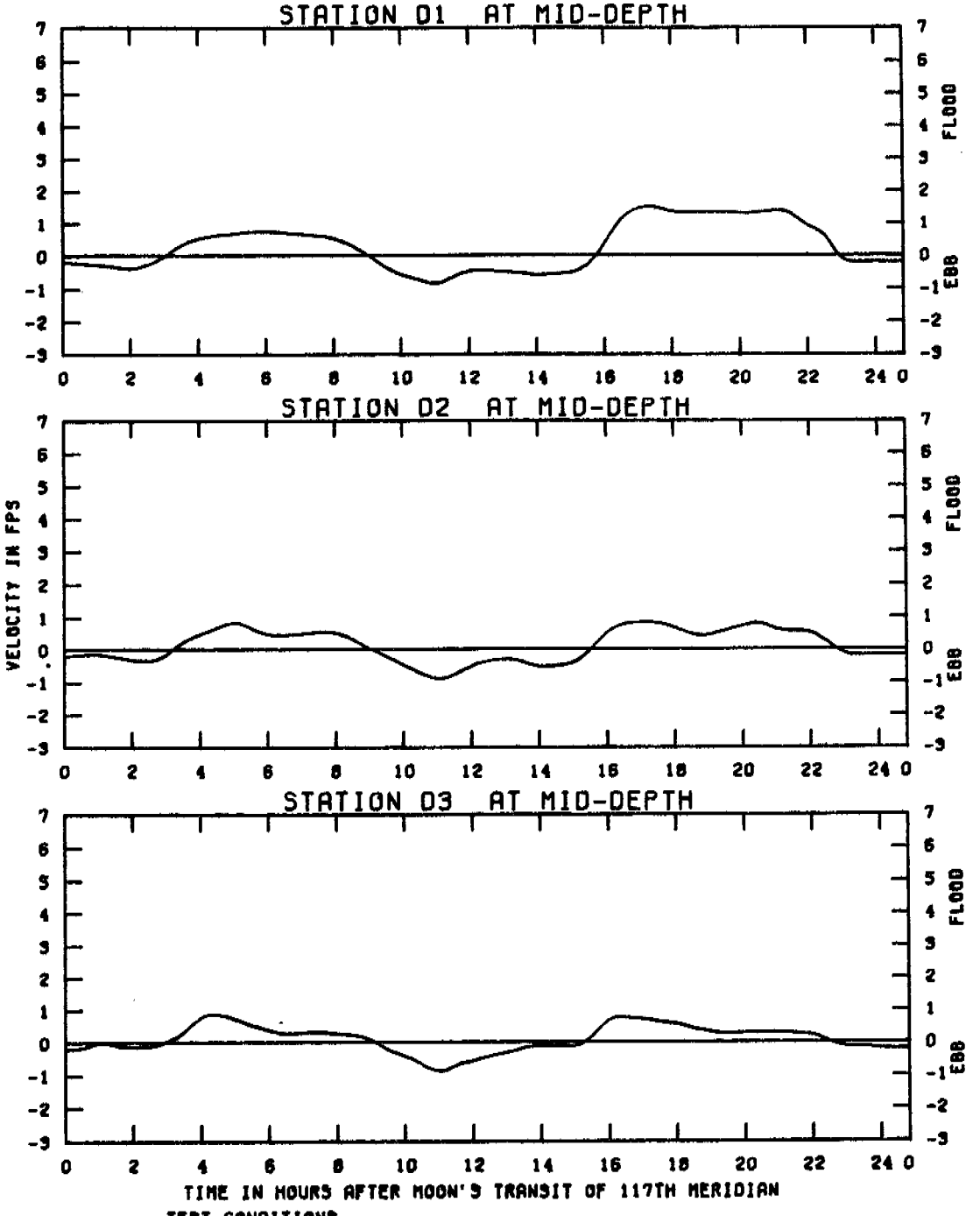
TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT

SAN DIEGO MODEL

VELOCITY OBSERVATIONS

STATIONS
C1 , C2 , AND C3

PLATE 6



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT

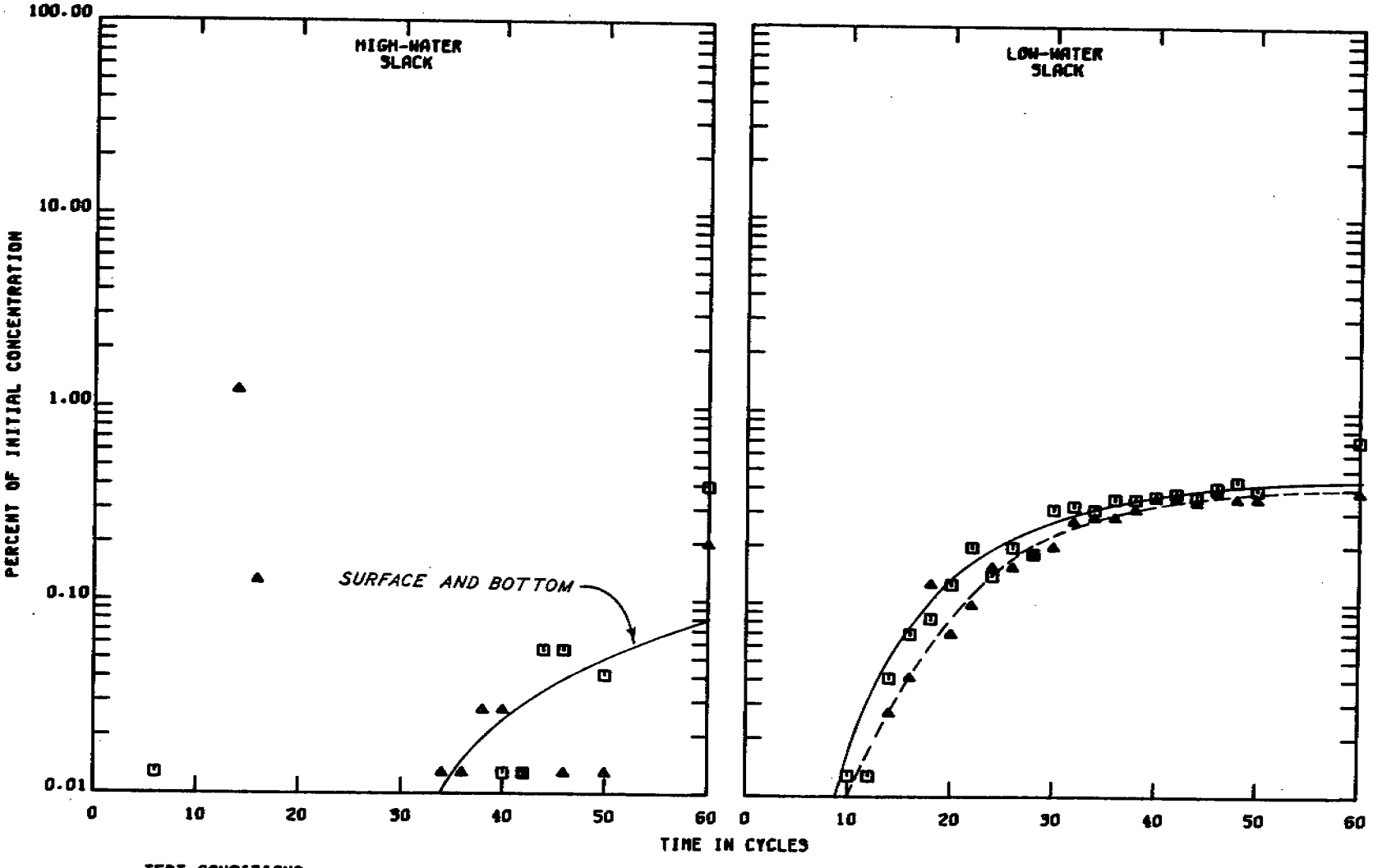
SAN DIEGO MODEL

VELOCITY OBSERVATIONS

STATIONS
01 , 02 , AND 03

PLATE 7

PLATE 8



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

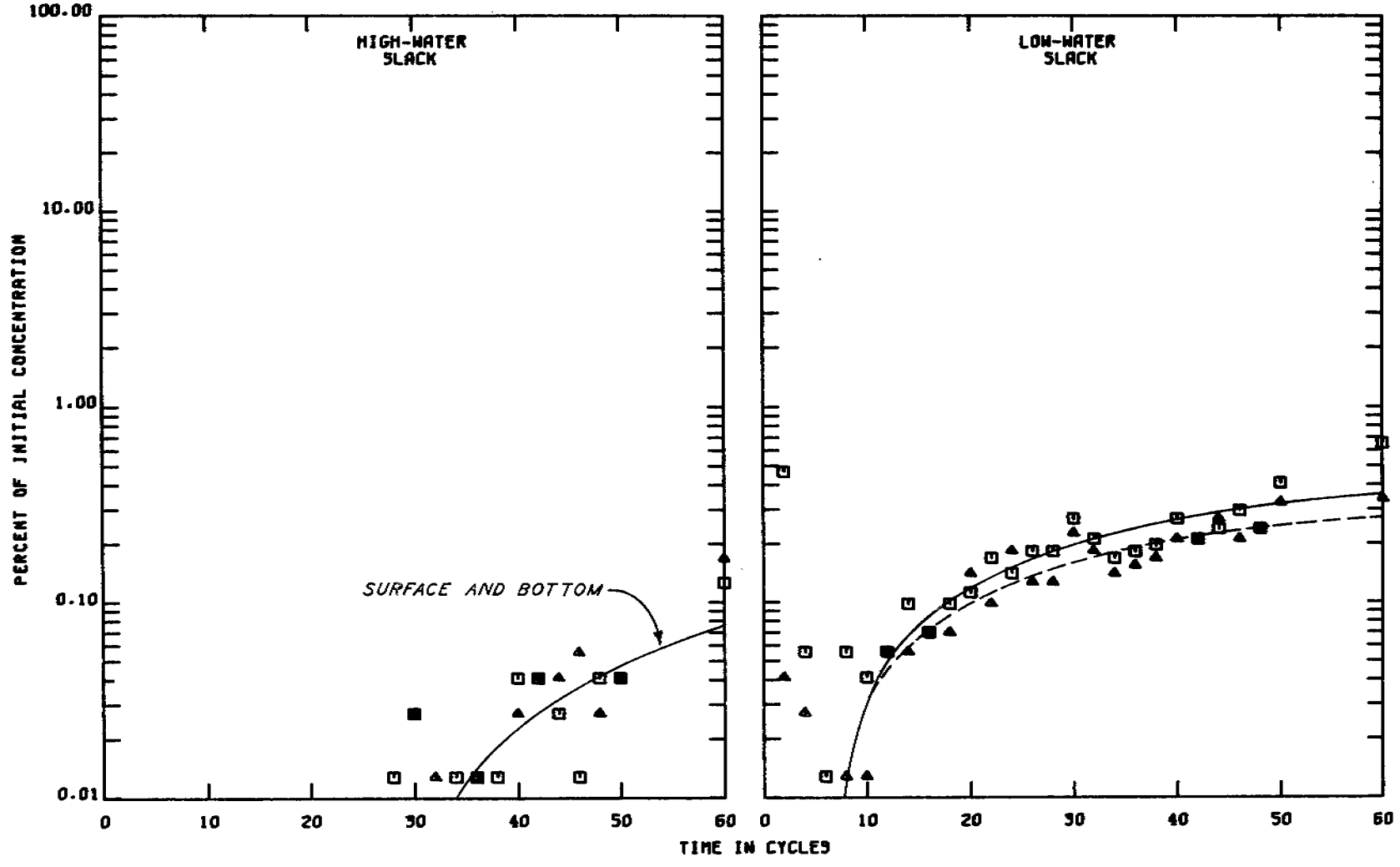
▲ — — — BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION A1



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

SAN DIEGO MODEL

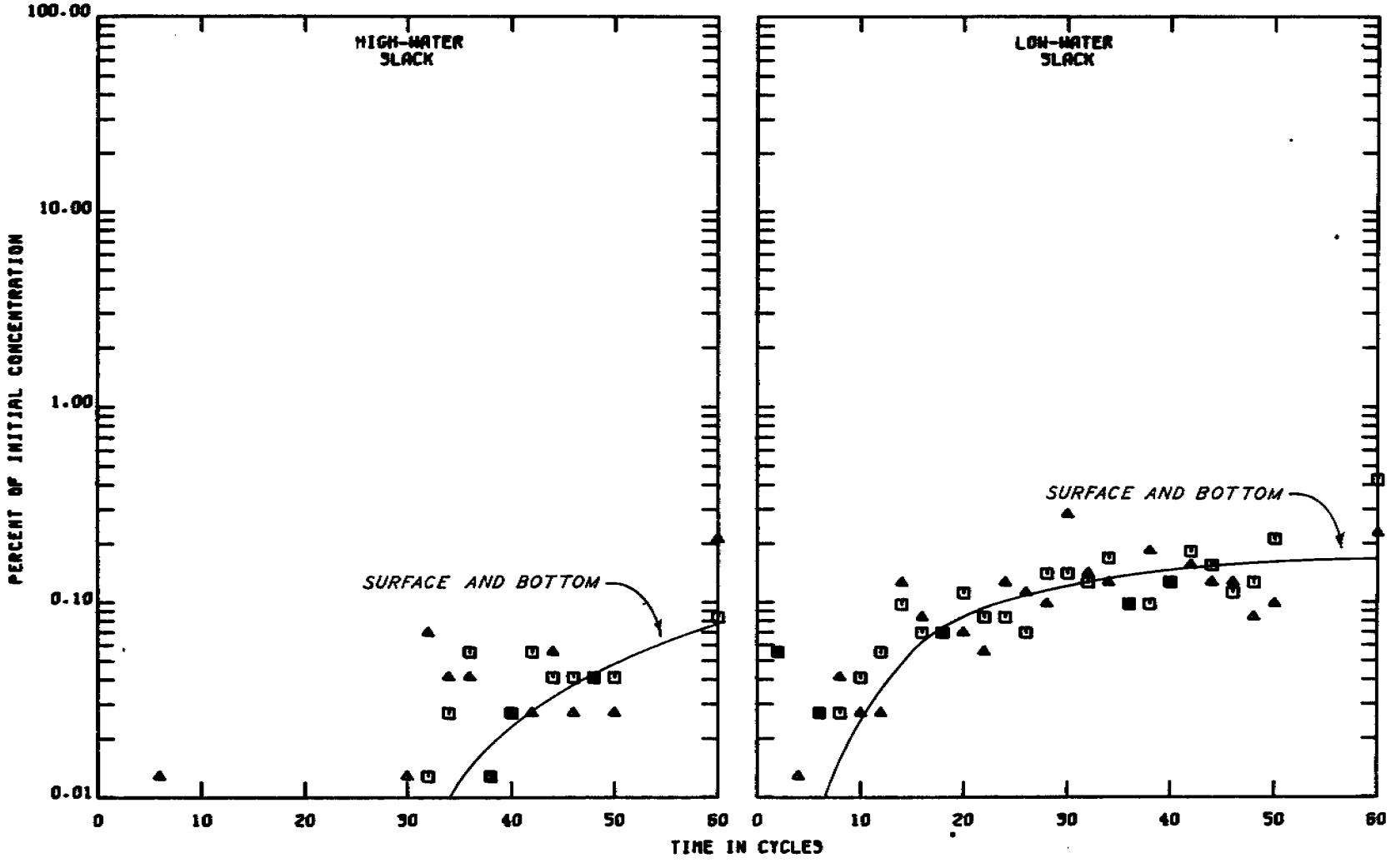
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION A2

PLATE 9

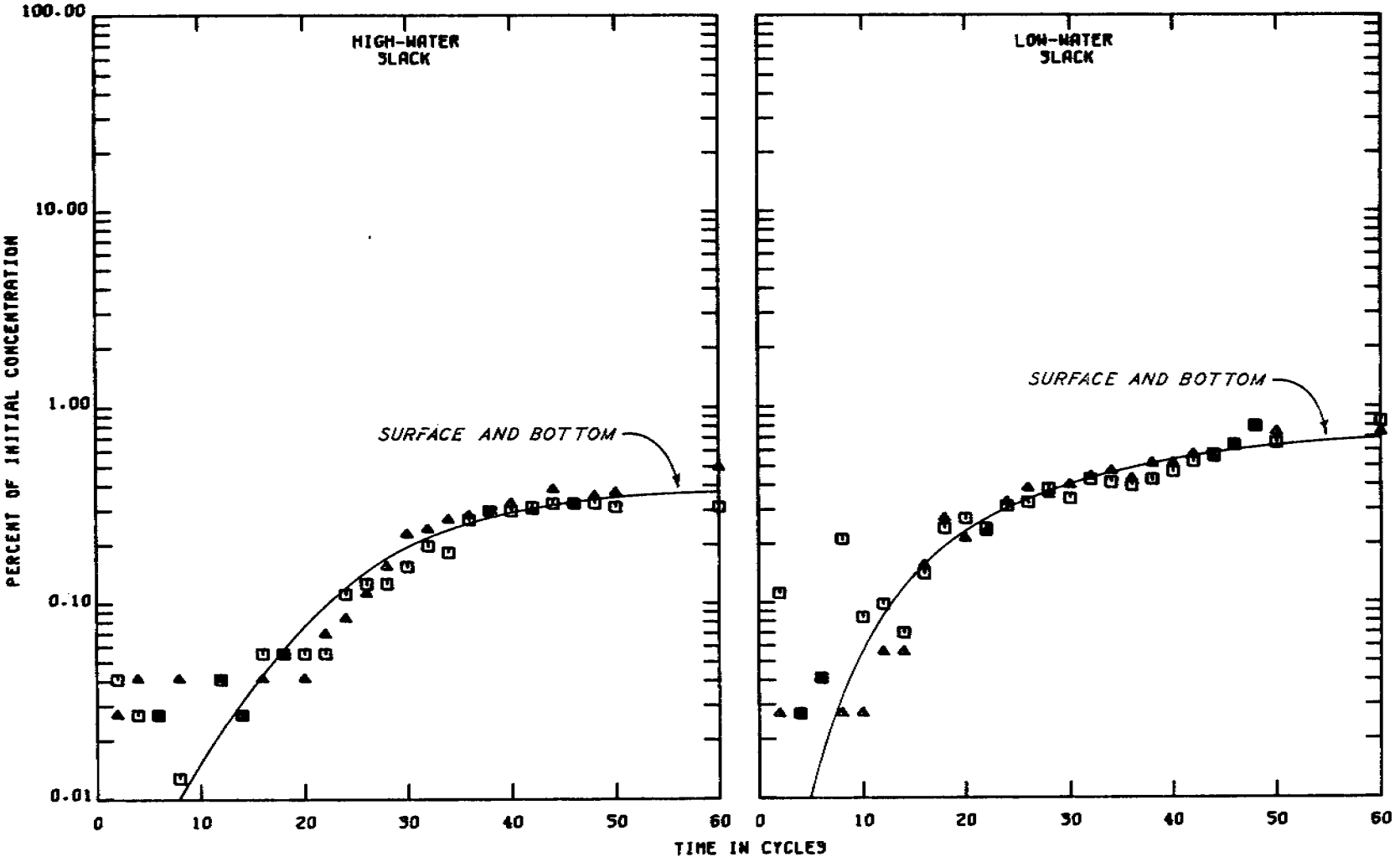
PLATE 10



TEST CONDITIONS	
TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND
□ —— SURFACE
△ - - - BOTTOM

SAN DIEGO MODEL
SALINE WATER DISPERSION TEST
10 MGD PLANT
STATION A3



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ — — — BOTTOM

SAN DIEGO MODEL

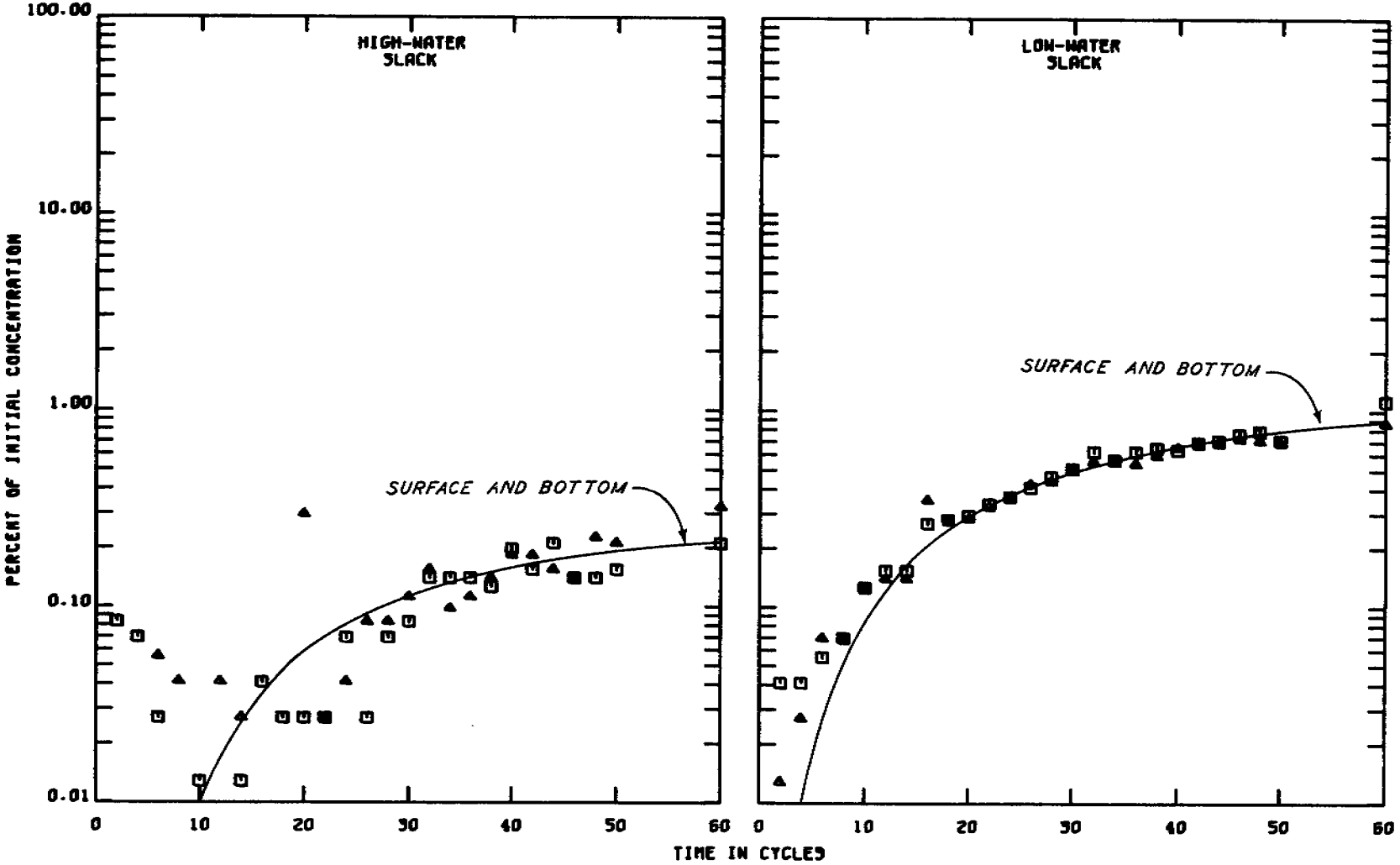
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION 81

PLATE 11

PLATE 12



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

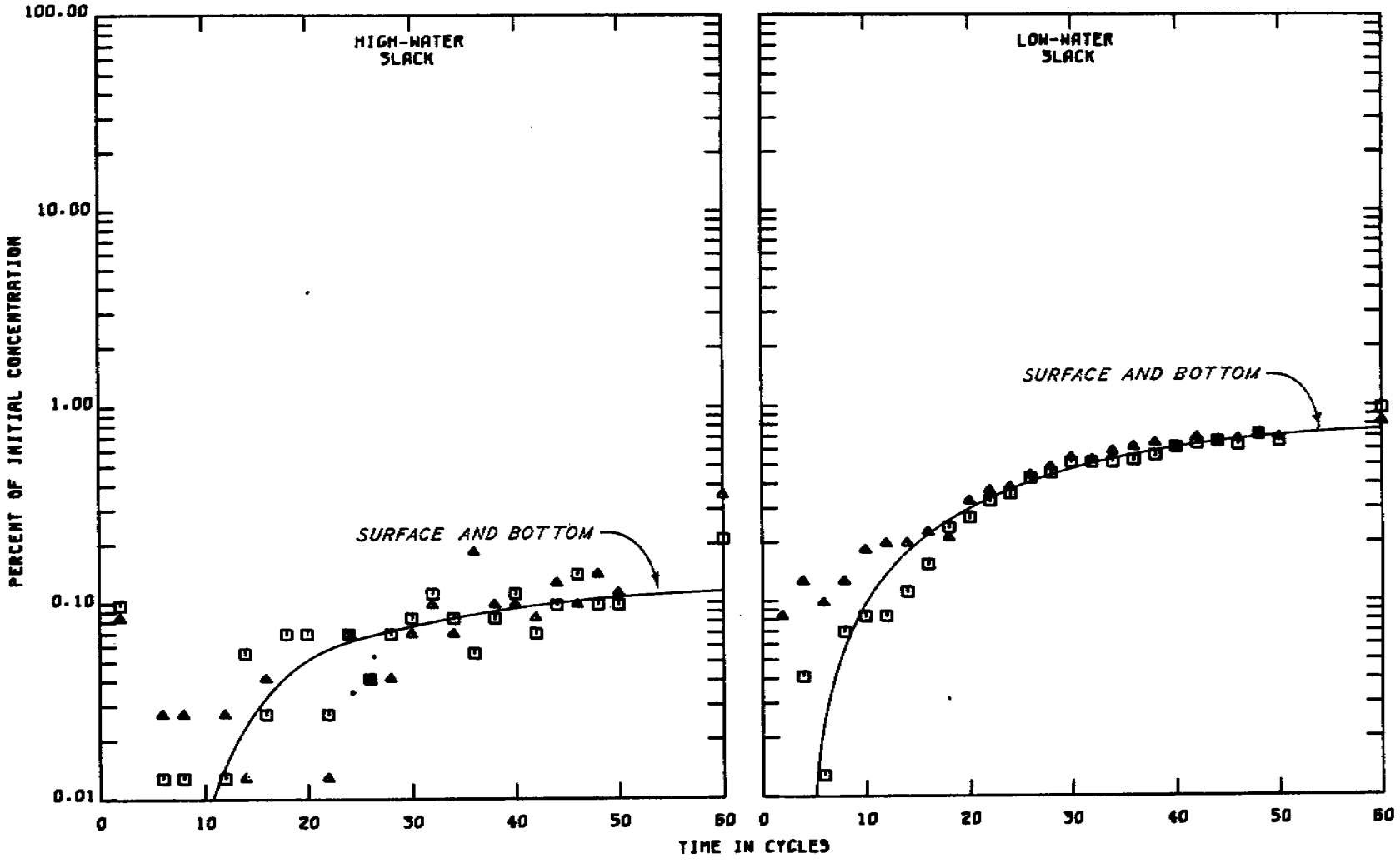
▲ — — — BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION 82



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

BOTTOM

SAN DIEGO MODEL

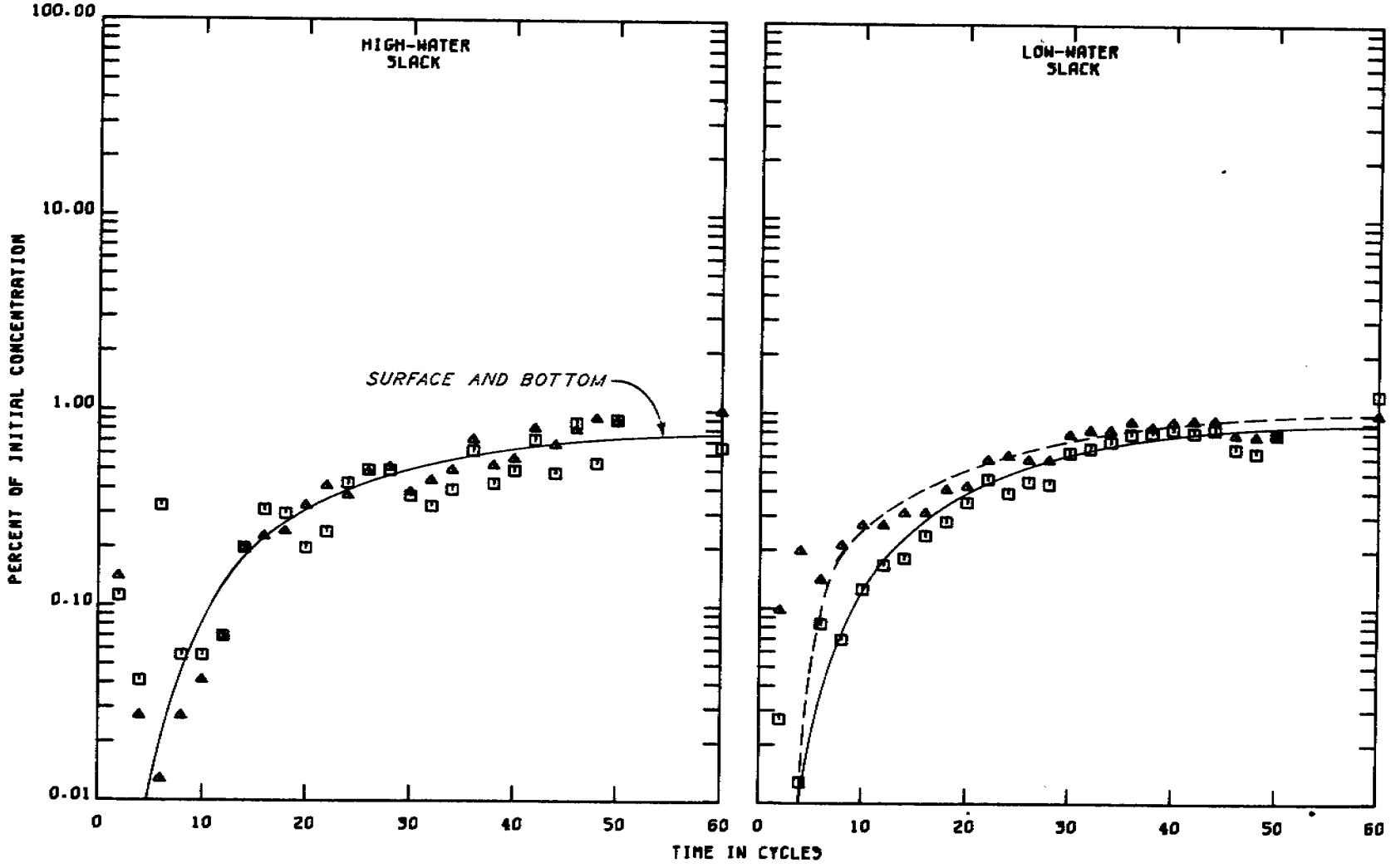
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION 83

PLATE 13

PLATE 14



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

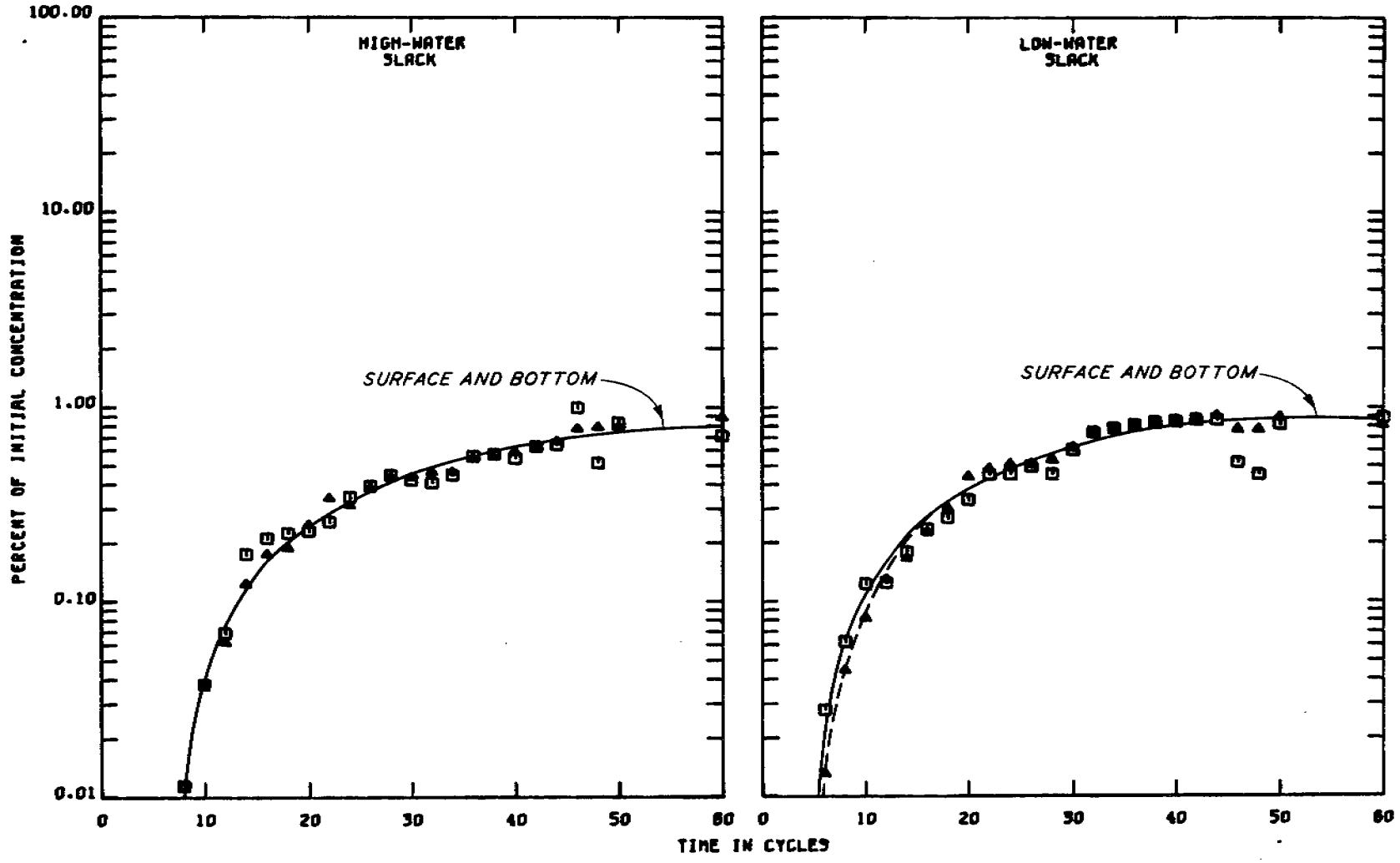
▲ – – – BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C1



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ — — — BOTTOM

SAN DIEGO MODEL

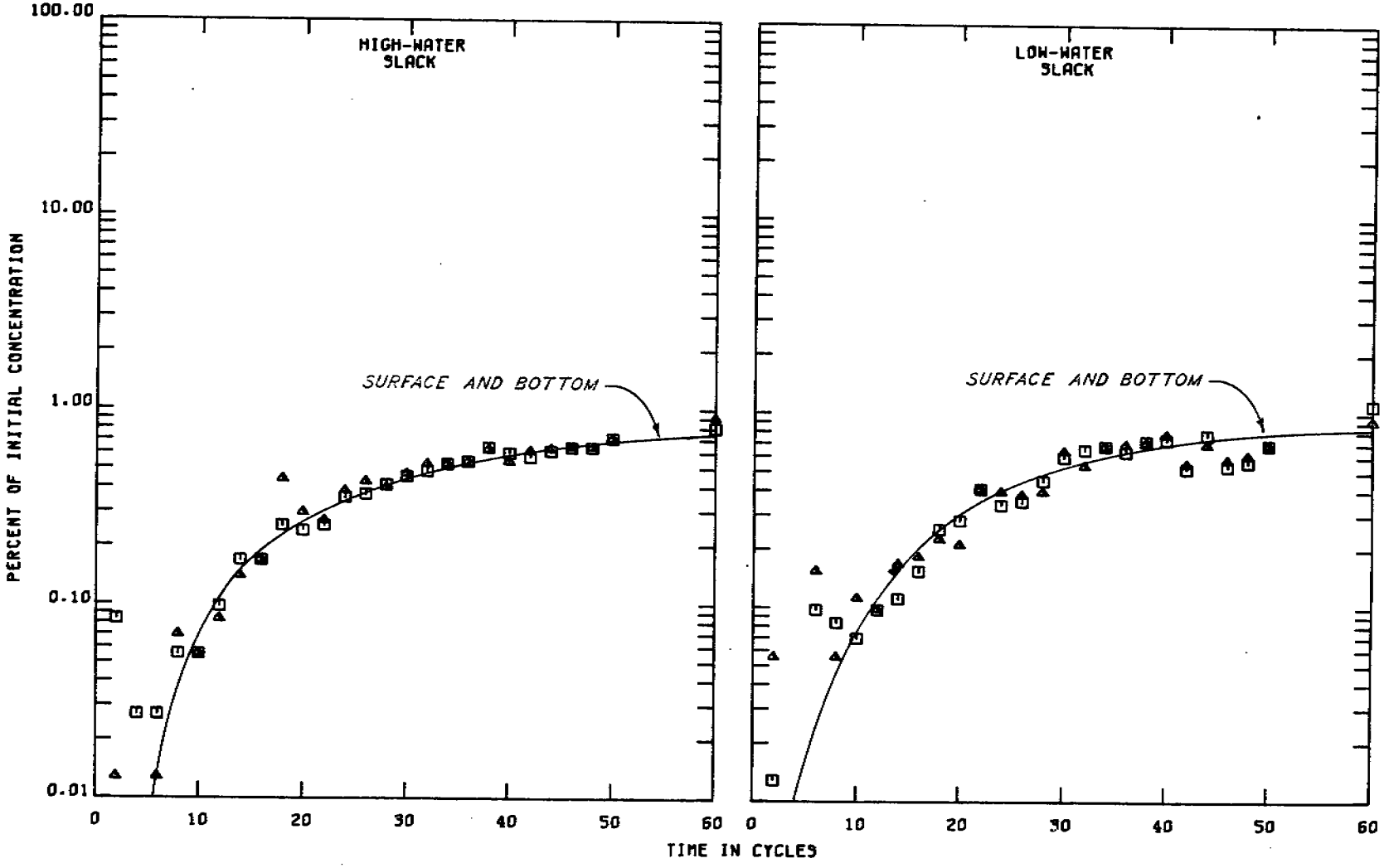
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C2

PLATE 15

PLATE 16



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

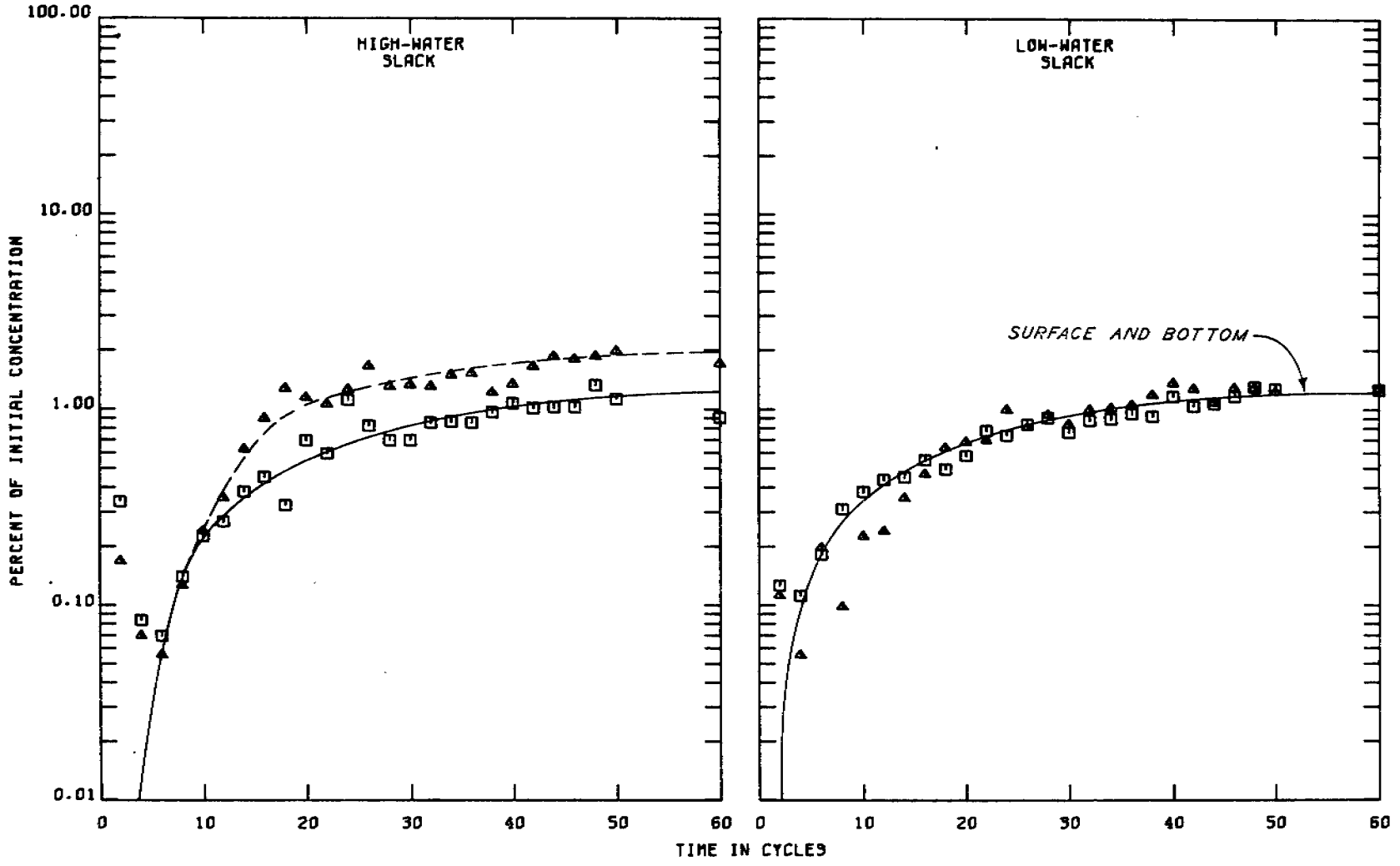
△ – – – BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C3



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

SAN DIEGO MODEL

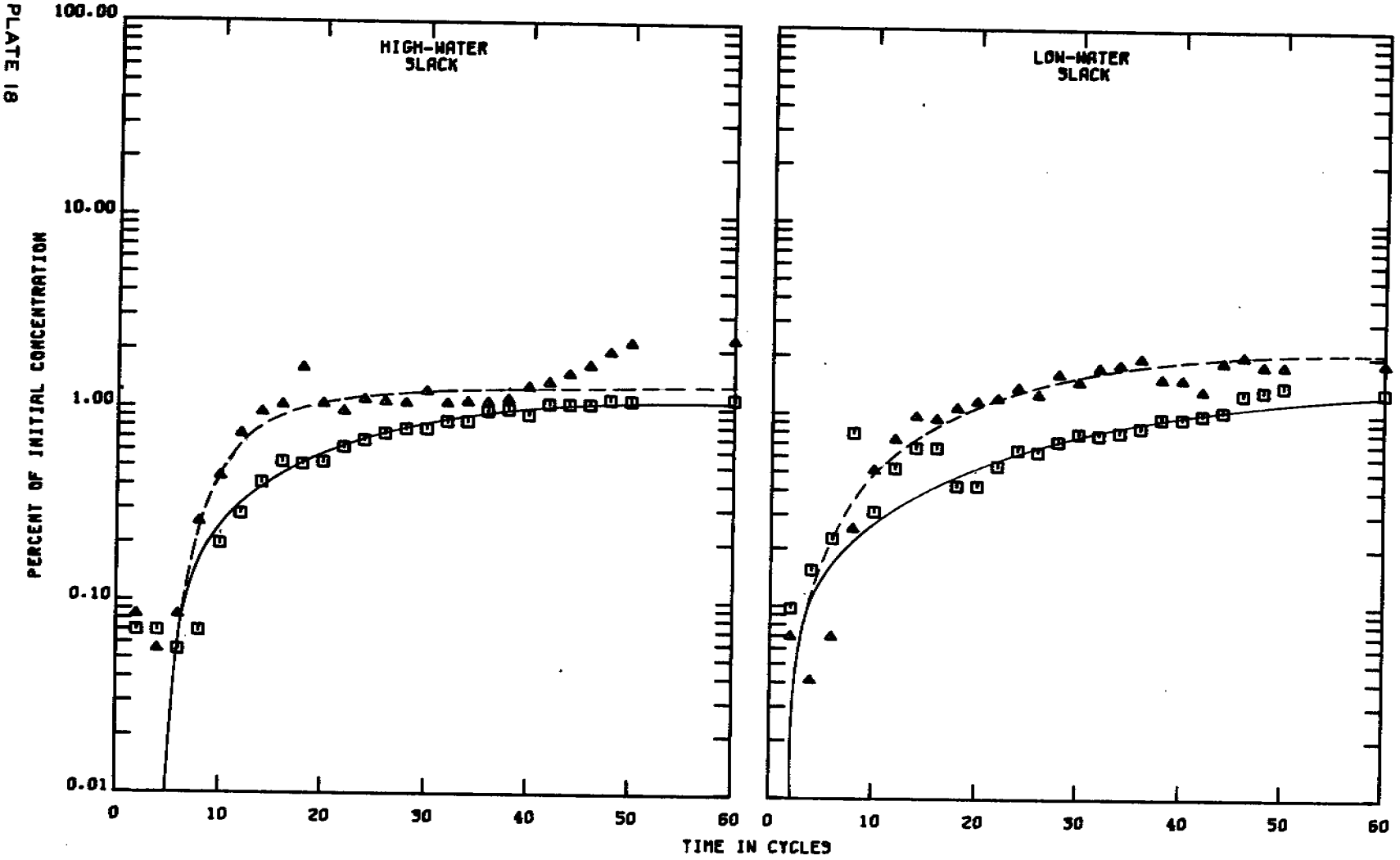
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION D1

PLATE 17

PLATE 18



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

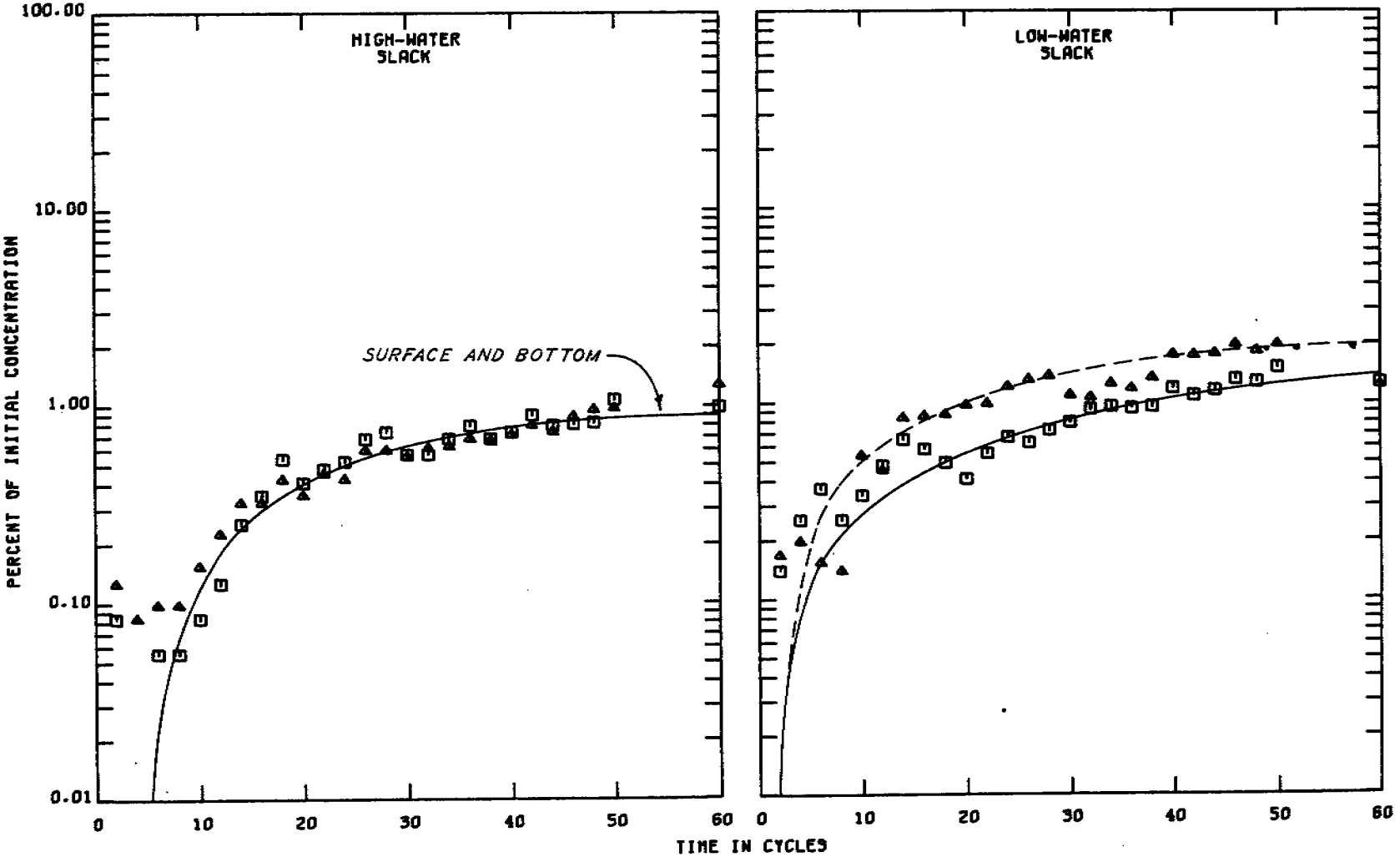
□ ——— SURFACE

▲ — — — BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ — — — BOTTOM

SAN DIEGO MODEL

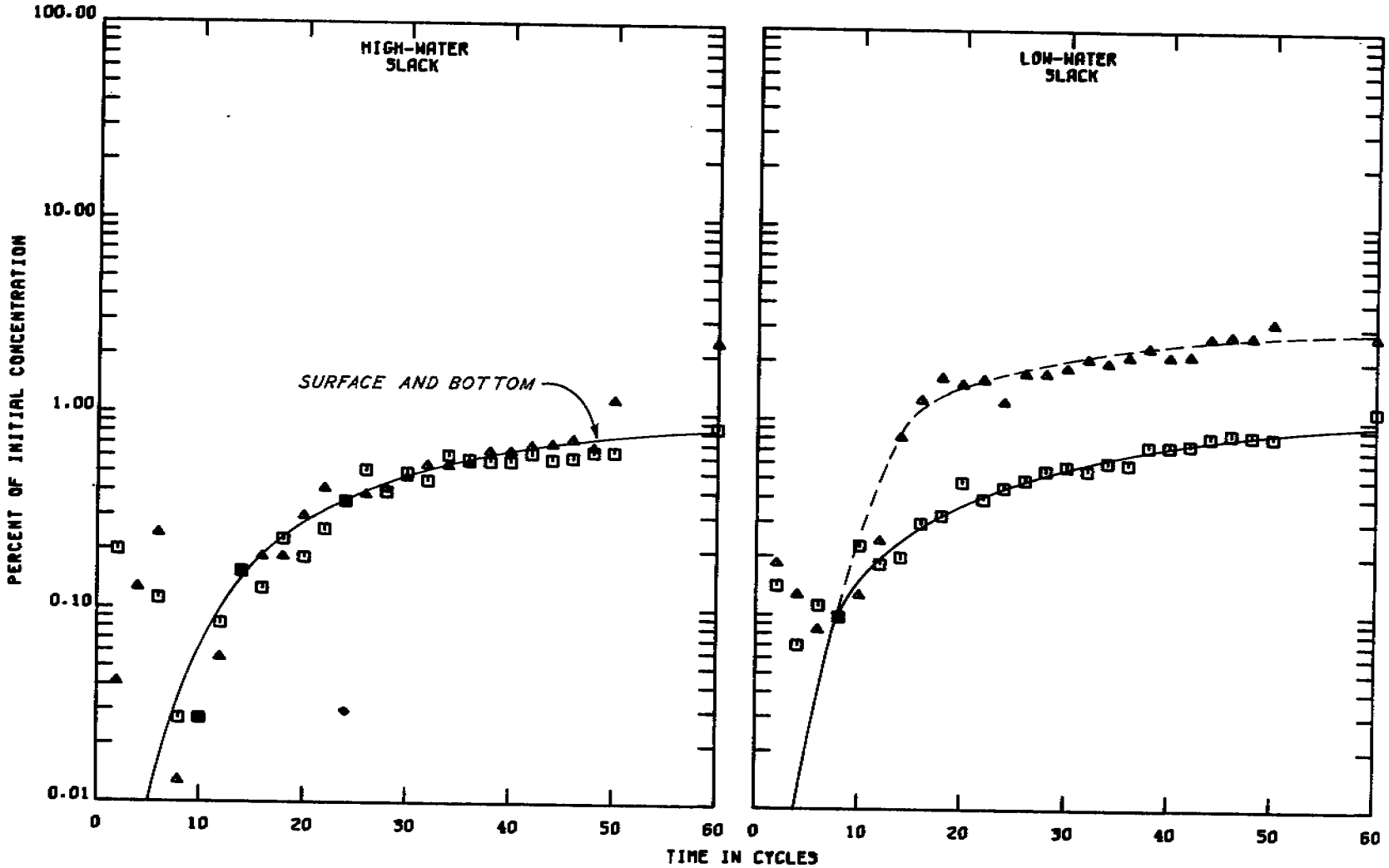
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION D3

PLATE 19

PLATE 20



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

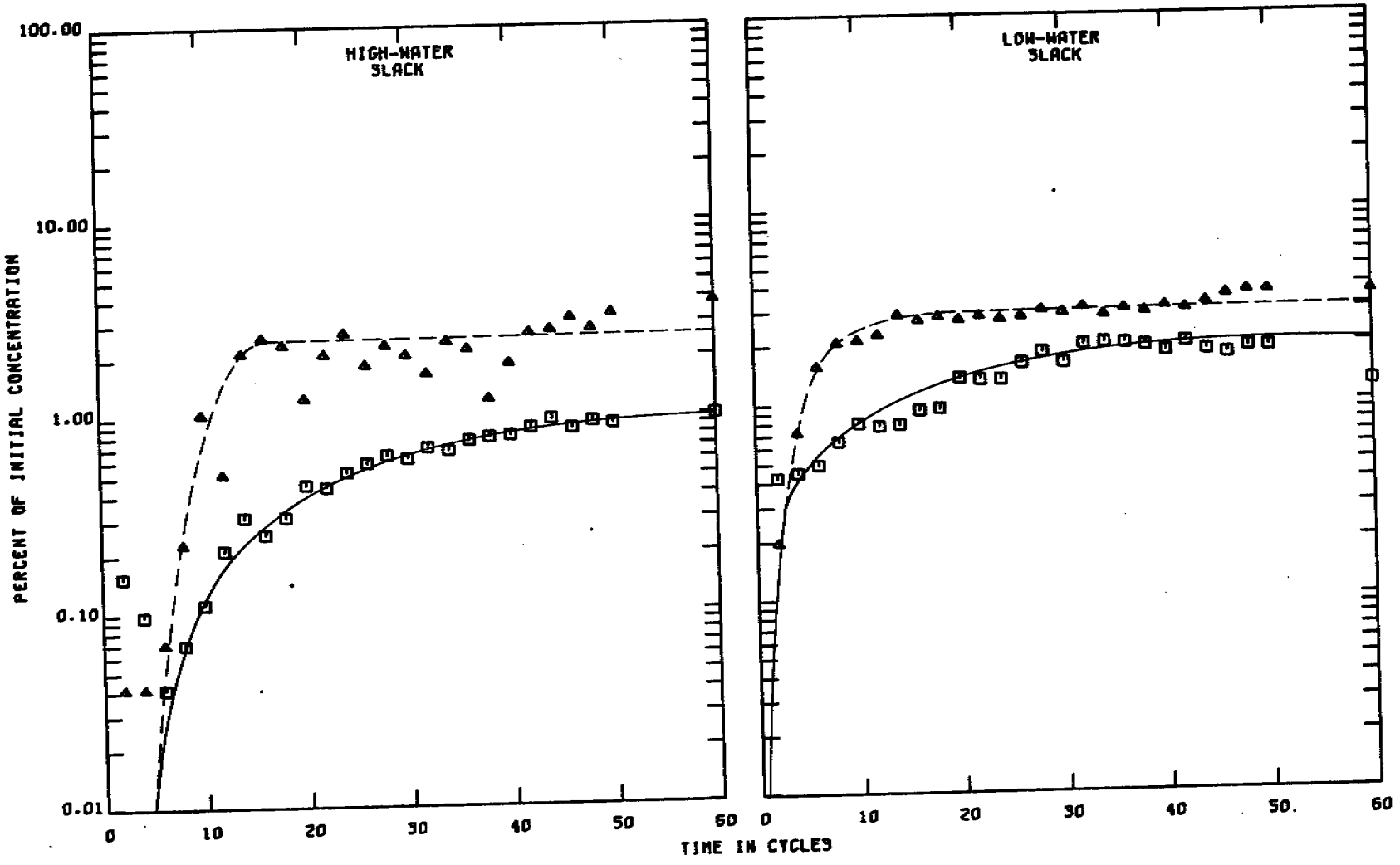
▲ – – – BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION D4



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

△ - - - BOTTOM

SAN DIEGO MODEL

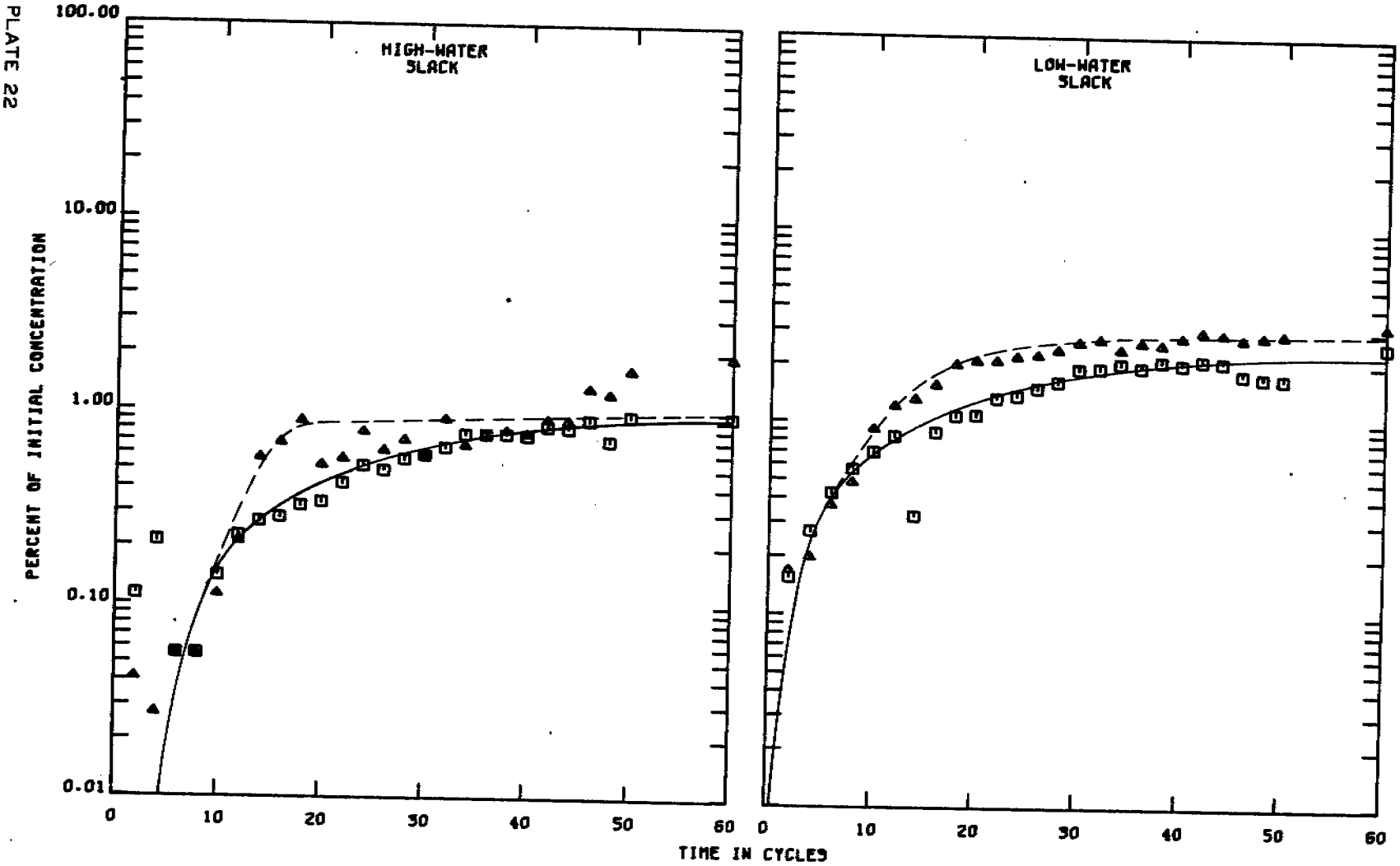
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION E1

PLATE 21

PLATE 22



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

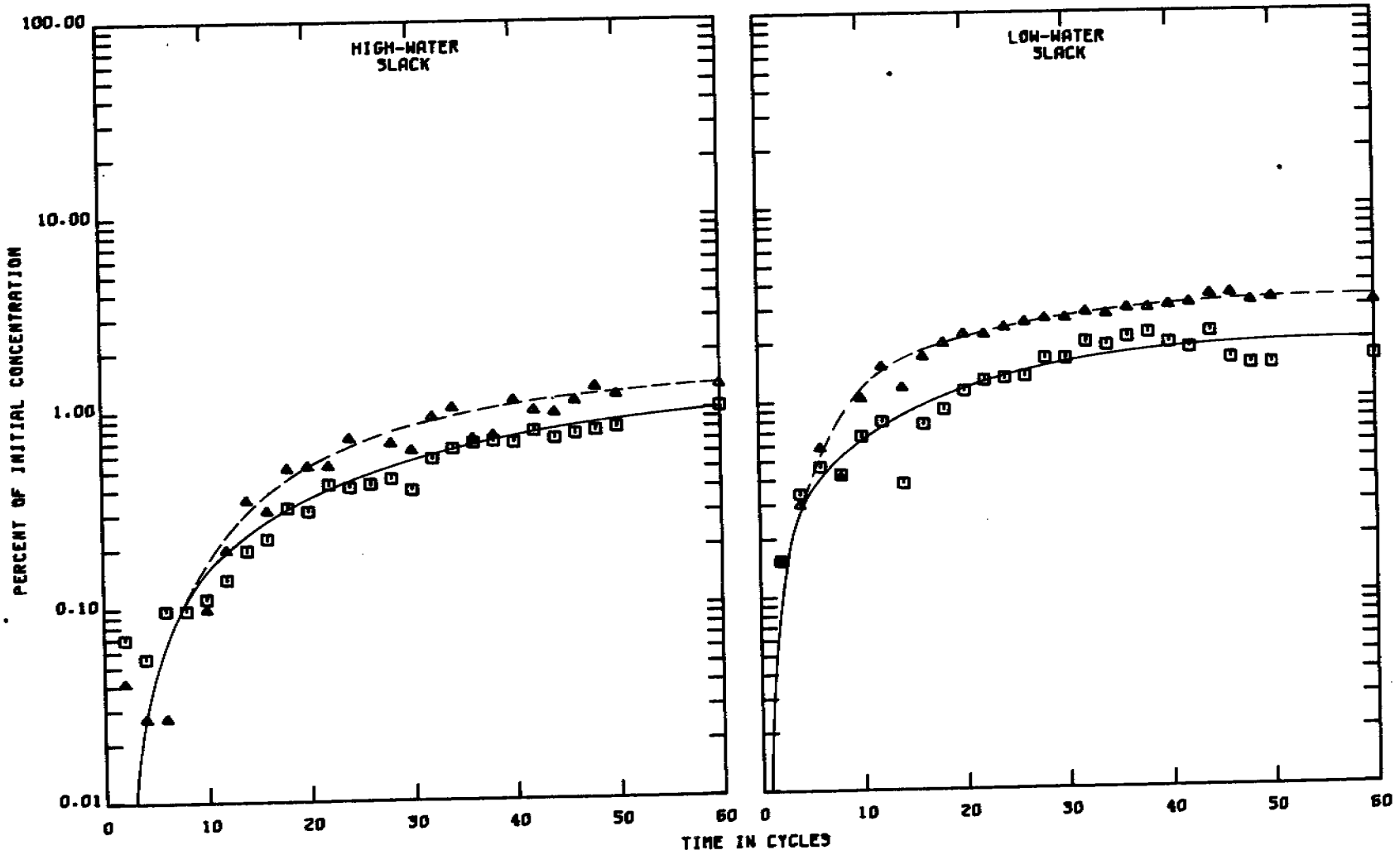
▲ – – – BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION E2



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

SAN DIEGO MODEL

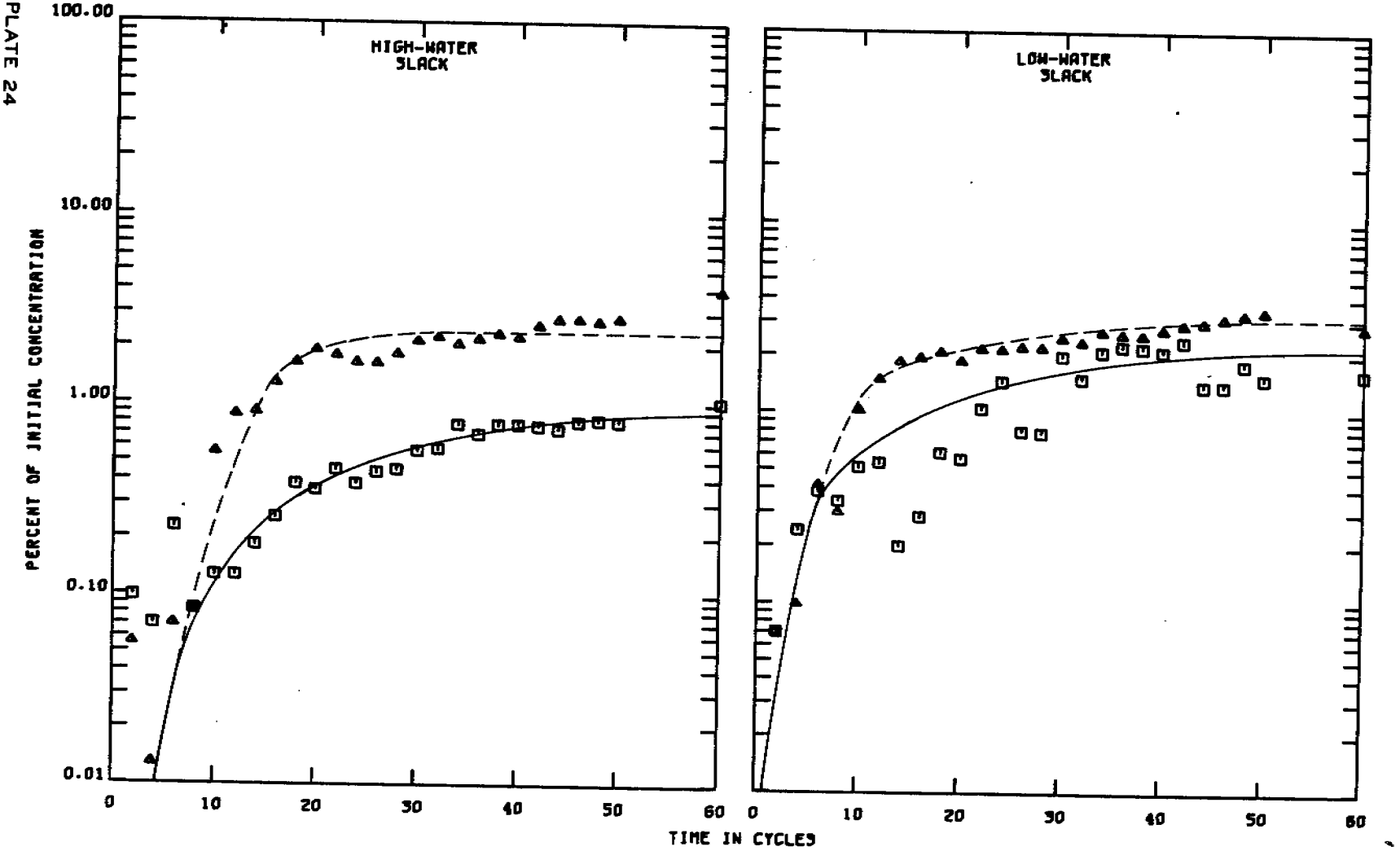
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION E3

PLATE 23

PLATE 24

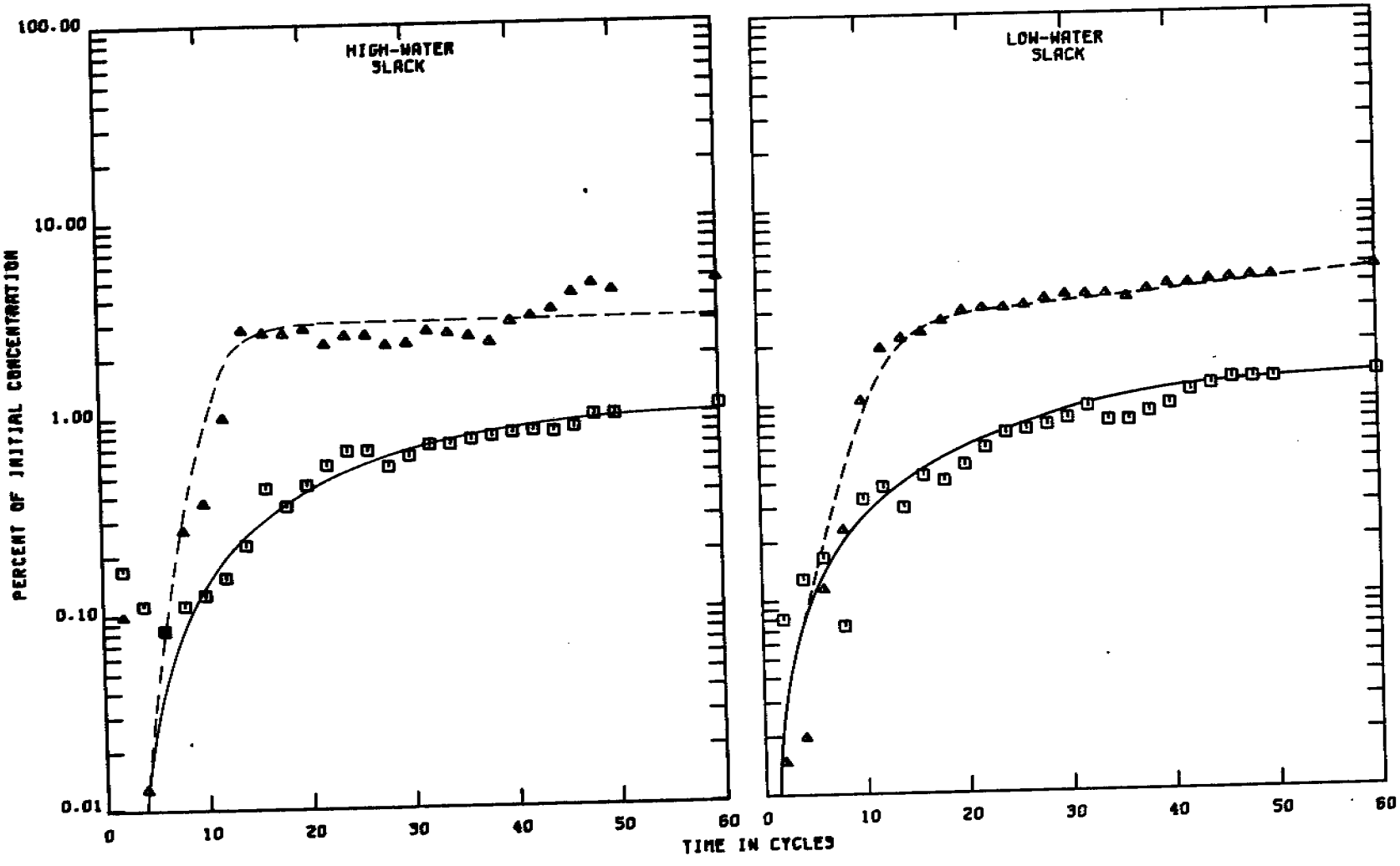


TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND
□ ——— SURFACE
▲ – – – BOTTOM

SAN DIEGO MODEL
SALINE WATER DISPERSION TEST
10 MGD PLANT
STATION E4



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

SAN DIEGO MODEL

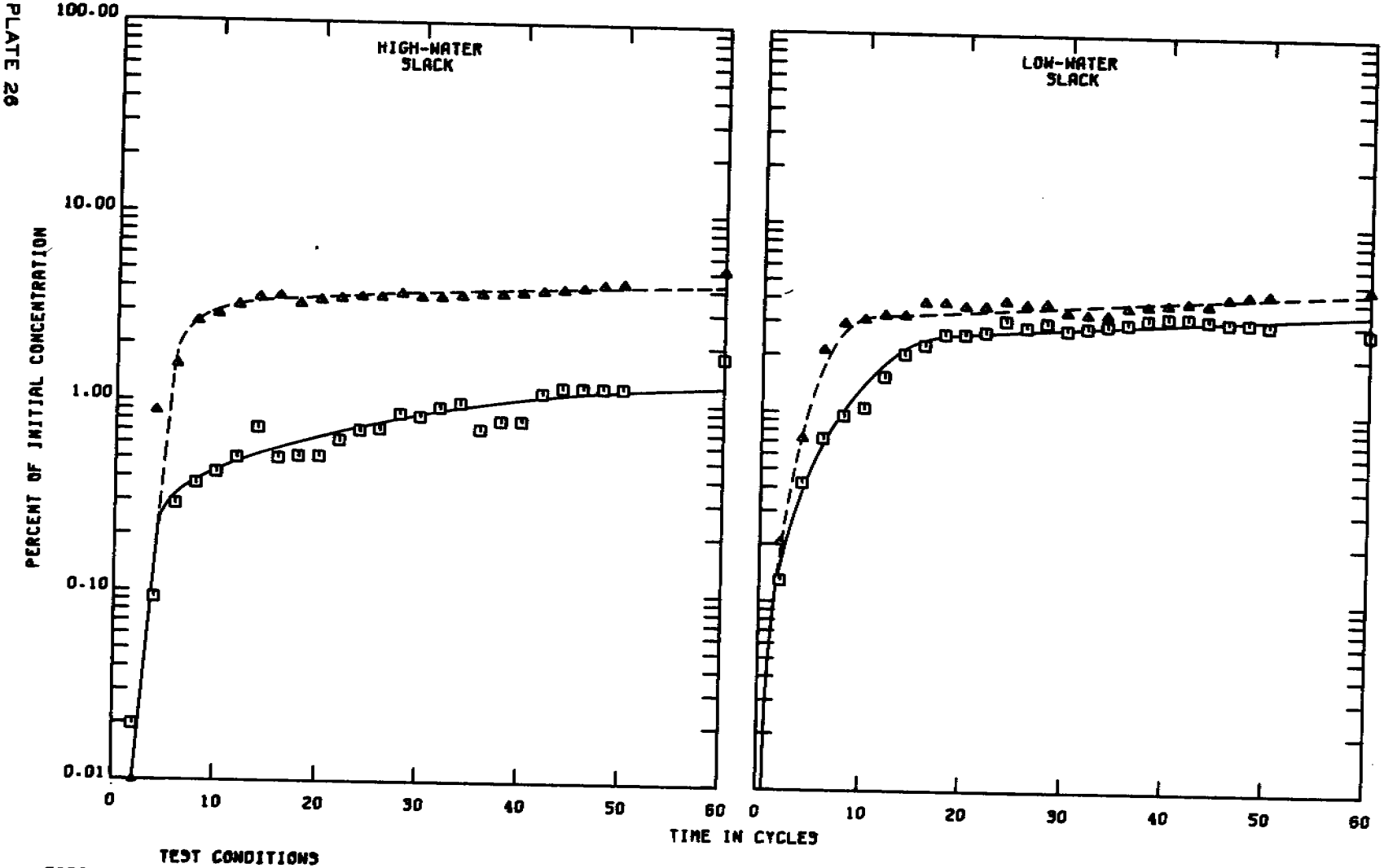
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION E5

PLATE 25

PLATE 28



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

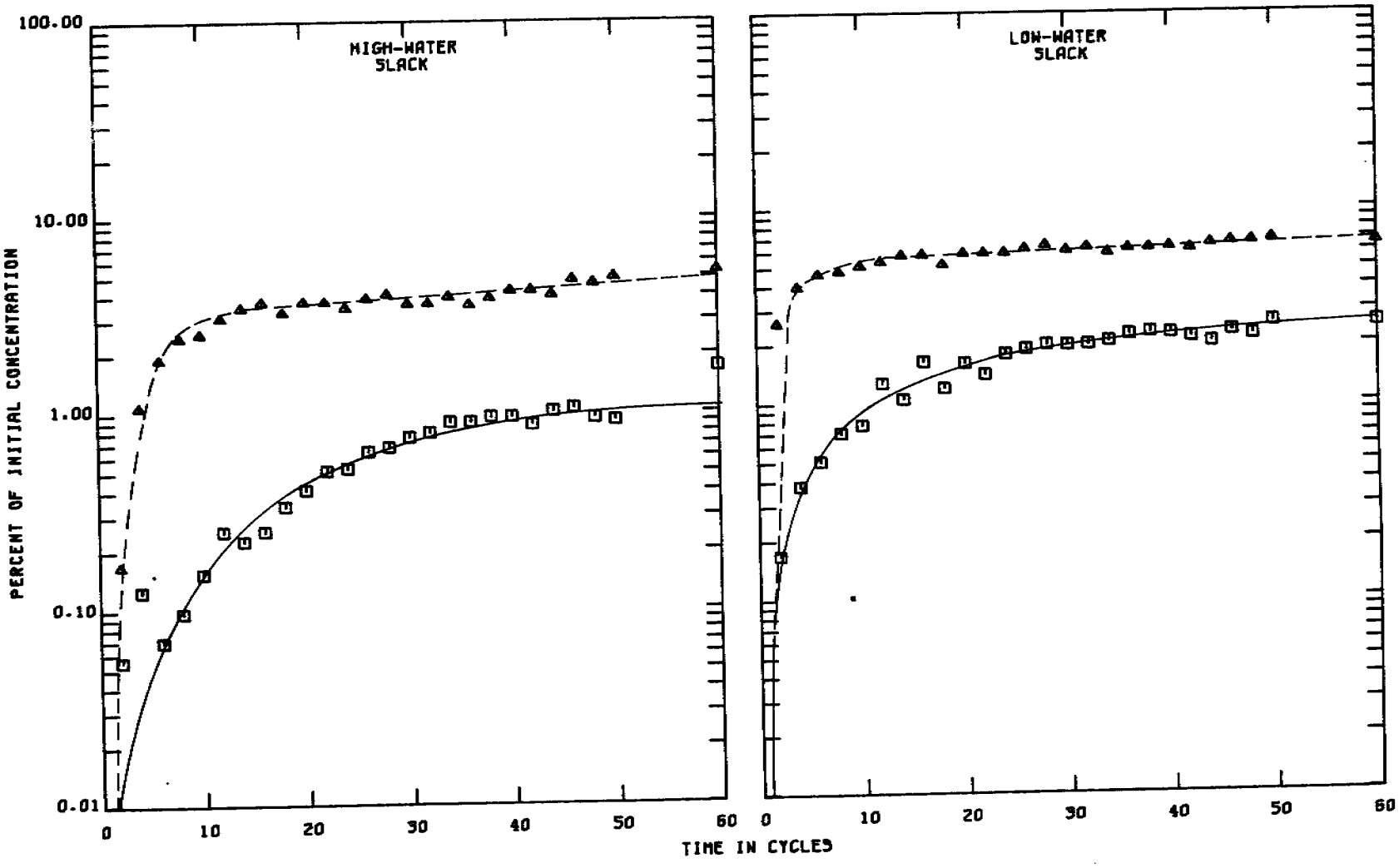
△ – – – BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION F1



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
• EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

SAN DIEGO MODEL

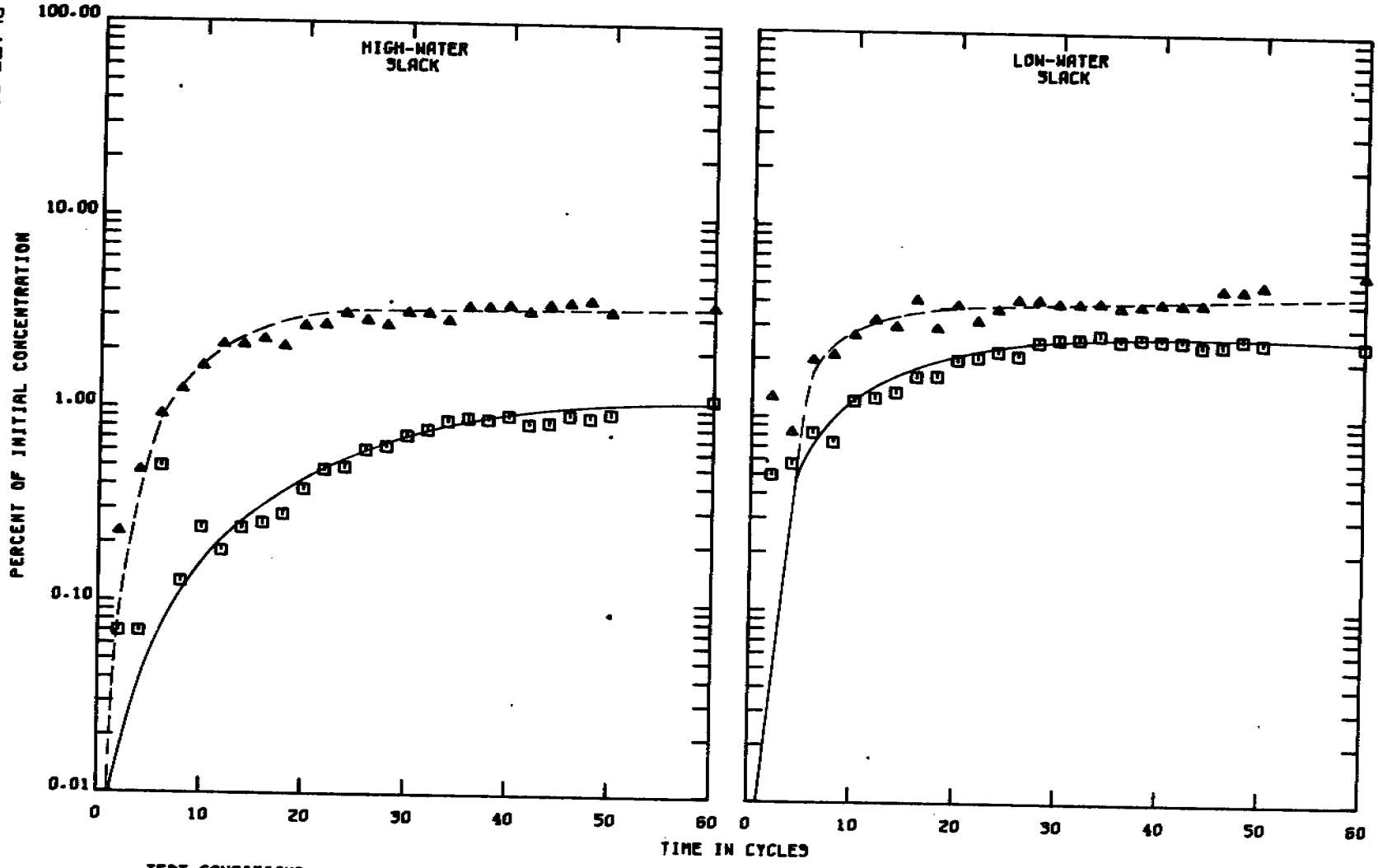
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION F2

PLATE 27

PLATE 28



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2	FT
OCEAN SALINITY (TOTAL SALT)	0.0	PPT
EFFLUENT CONCENTRATION	11.4	PPT
EFFLUENT INJECTION RATE	21.2	MGD

LEGEND

□ ——— SURFACE

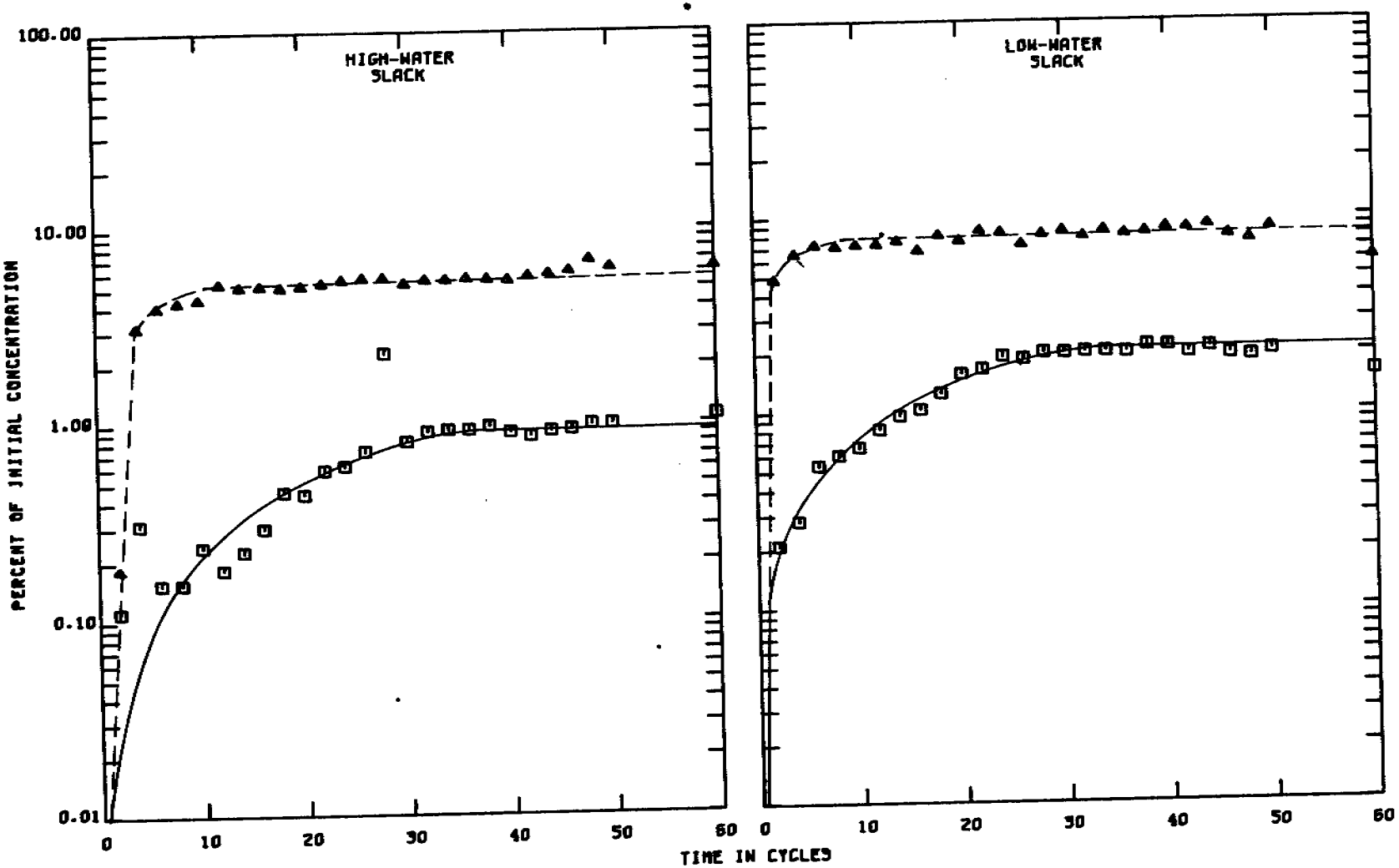
▲ – – – BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION F3



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

SAN DIEGO MODEL

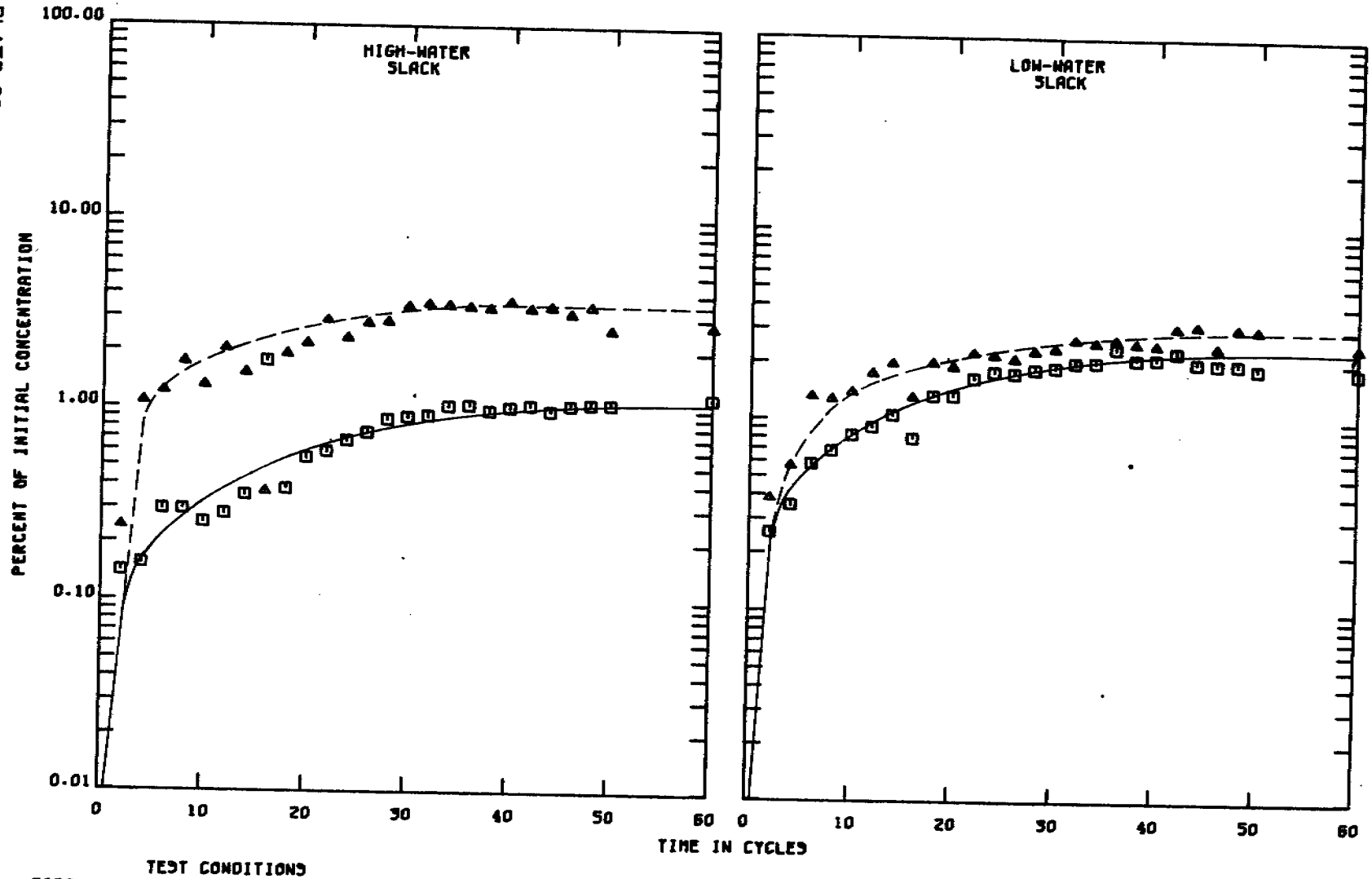
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION F4

PLATE 29

PLATE 30



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

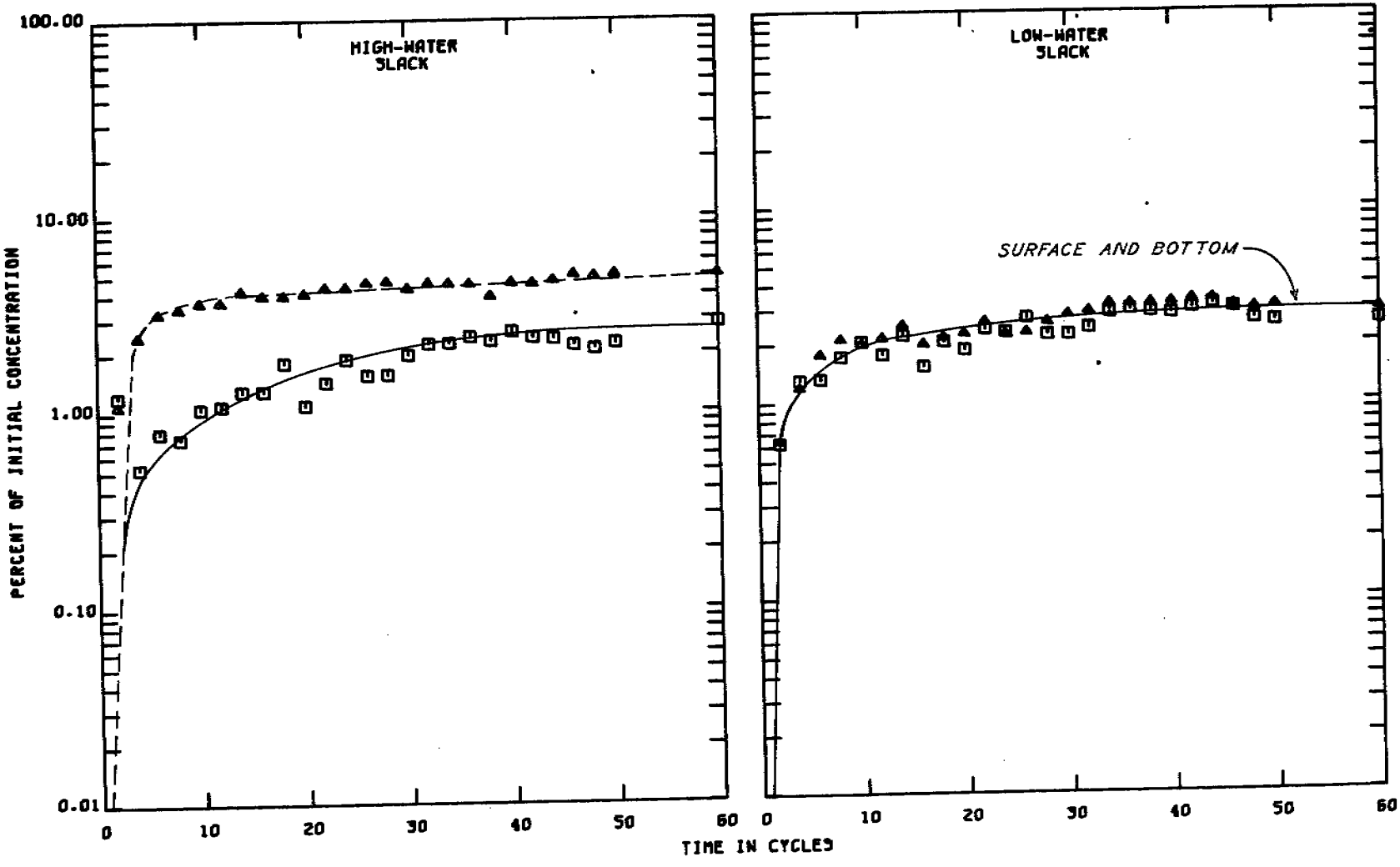
▲ – – – BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION F5



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

SAN DIEGO MODEL

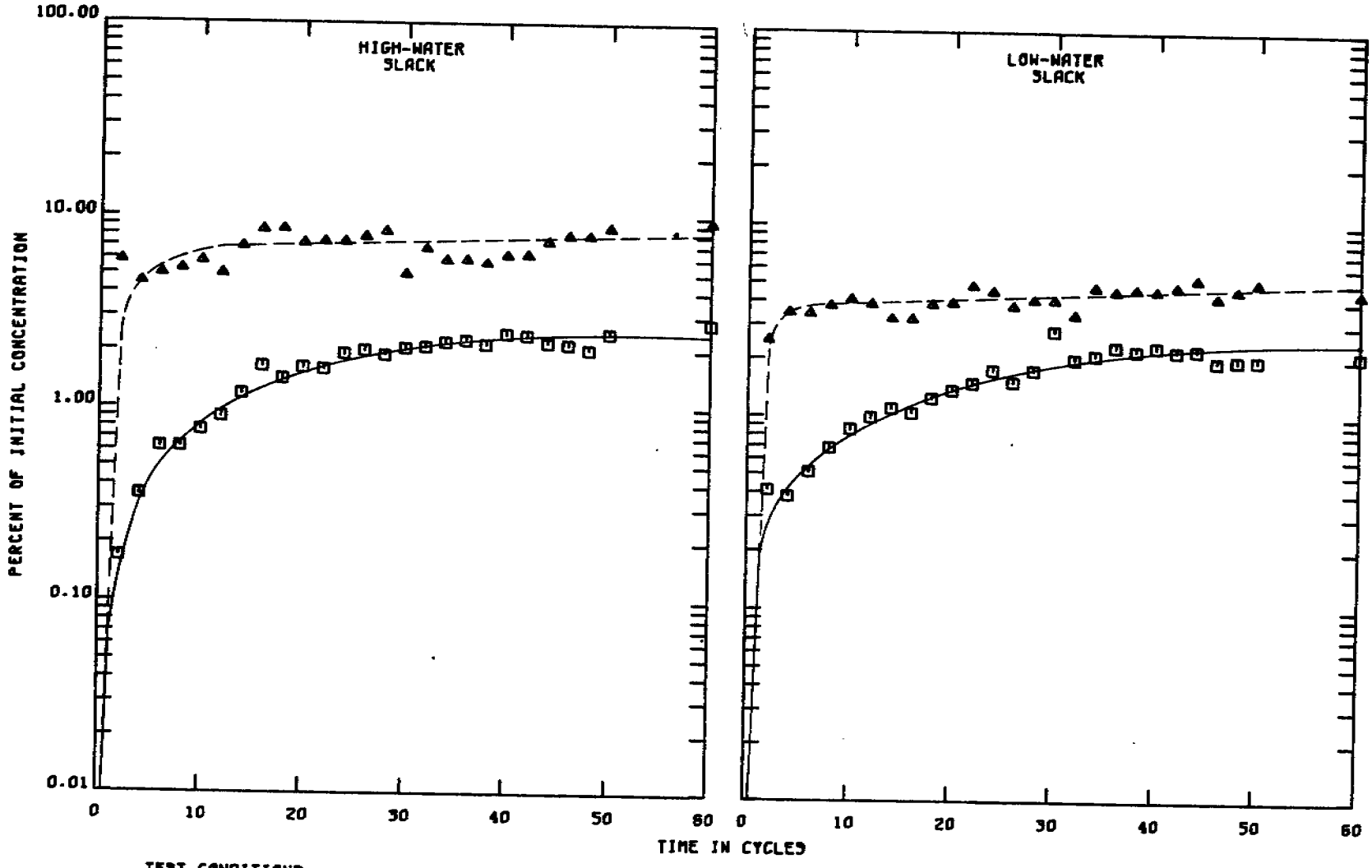
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION G1

PLATE 31

PLATE 32

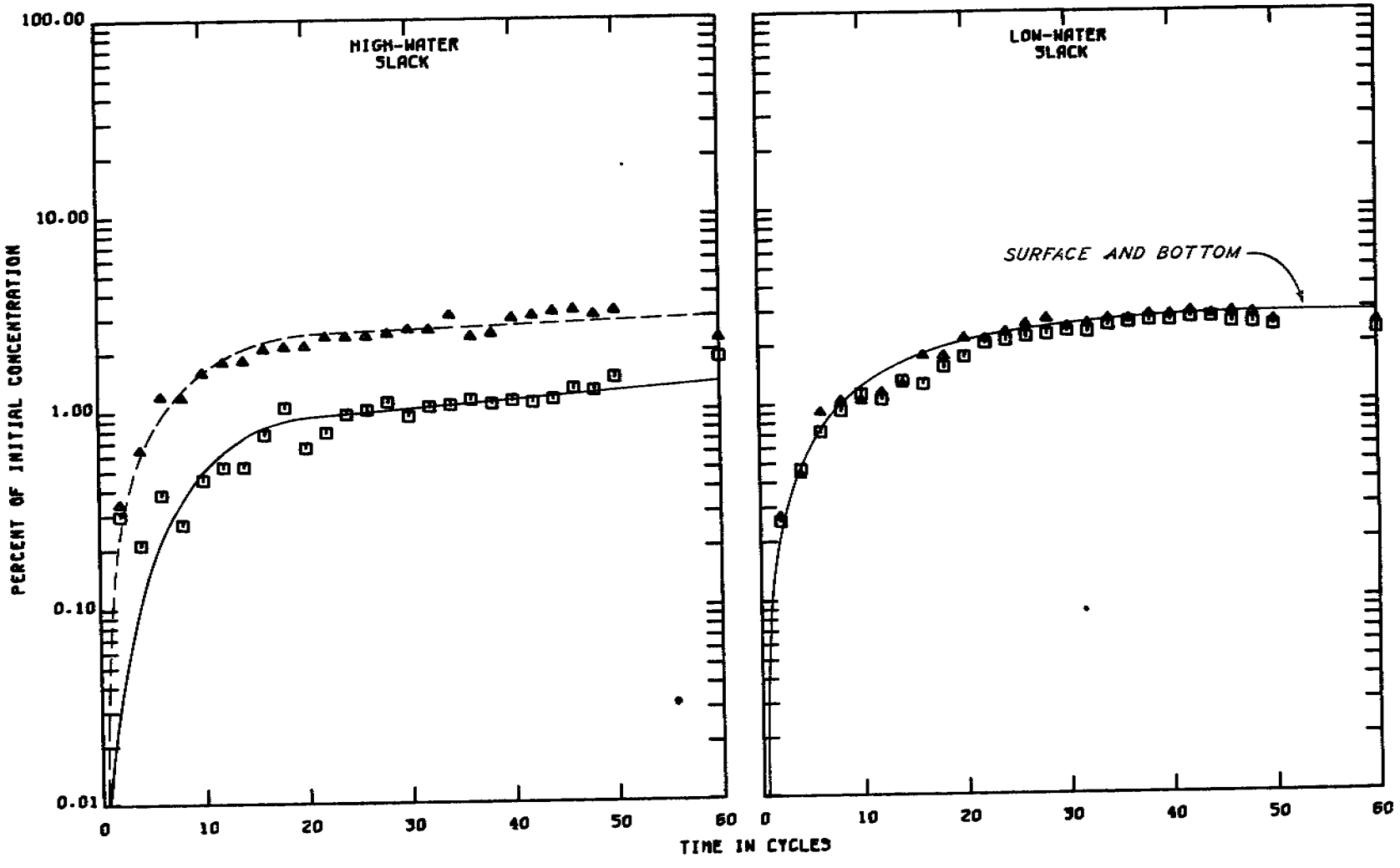


TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND
□ ——— SURFACE
△ – – – BOTTOM

SAN DIEGO MODEL
SALINE WATER DISPERSION TEST
10 MGD PLANT
STATION G2



TEST CONDITIONS.

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ — — — BOTTOM

SAN DIEGO MODEL

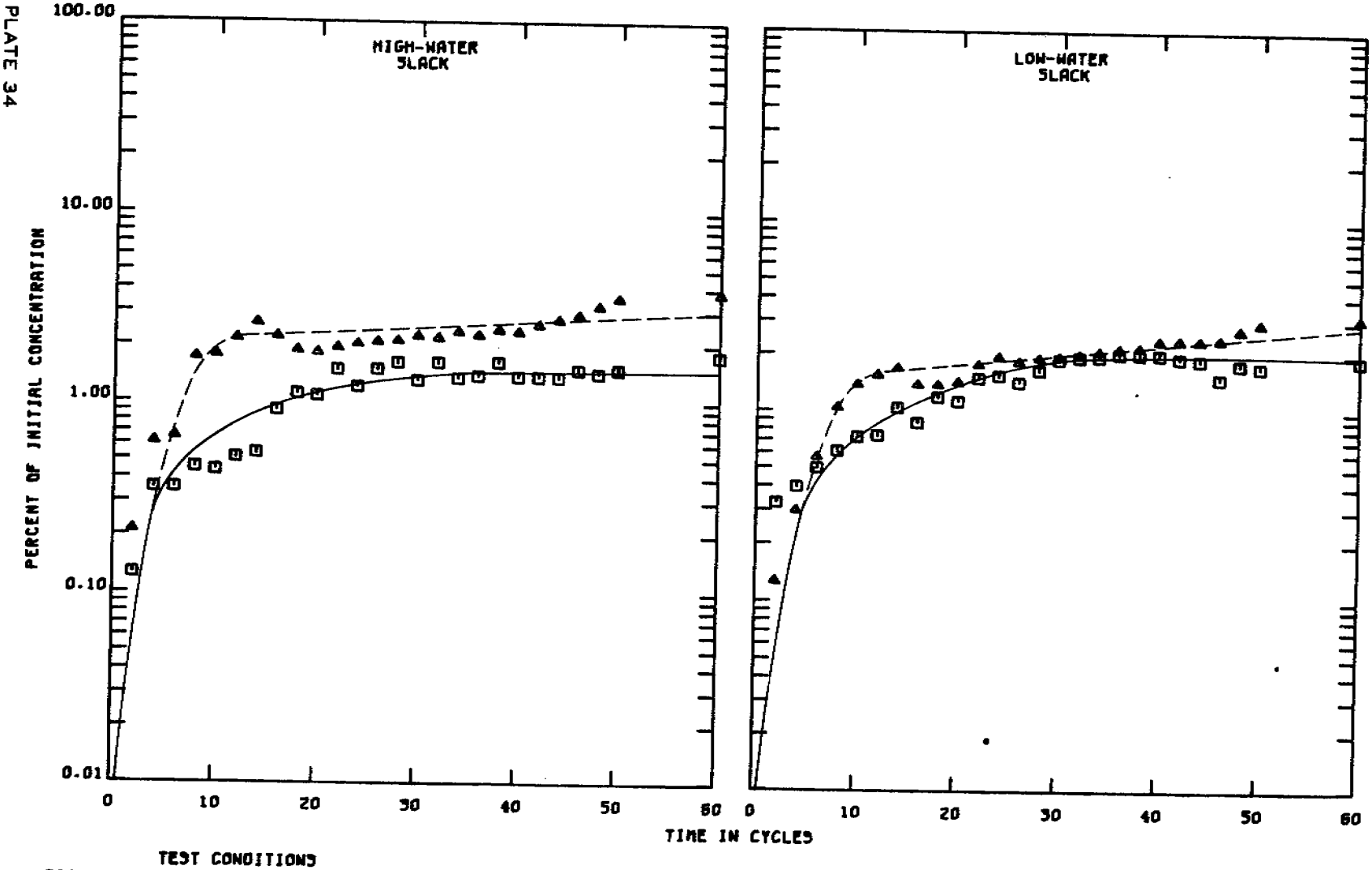
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION G3

PLATE 33

PLATE 34



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2	FT
OCEAN SALINITY (TOTAL SALT)	0.0	PPT
EFFLUENT CONCENTRATION	11.4	PPT
EFFLUENT INJECTION RATE	21.2	MGD

LEGEND

□ ——— SURFACE

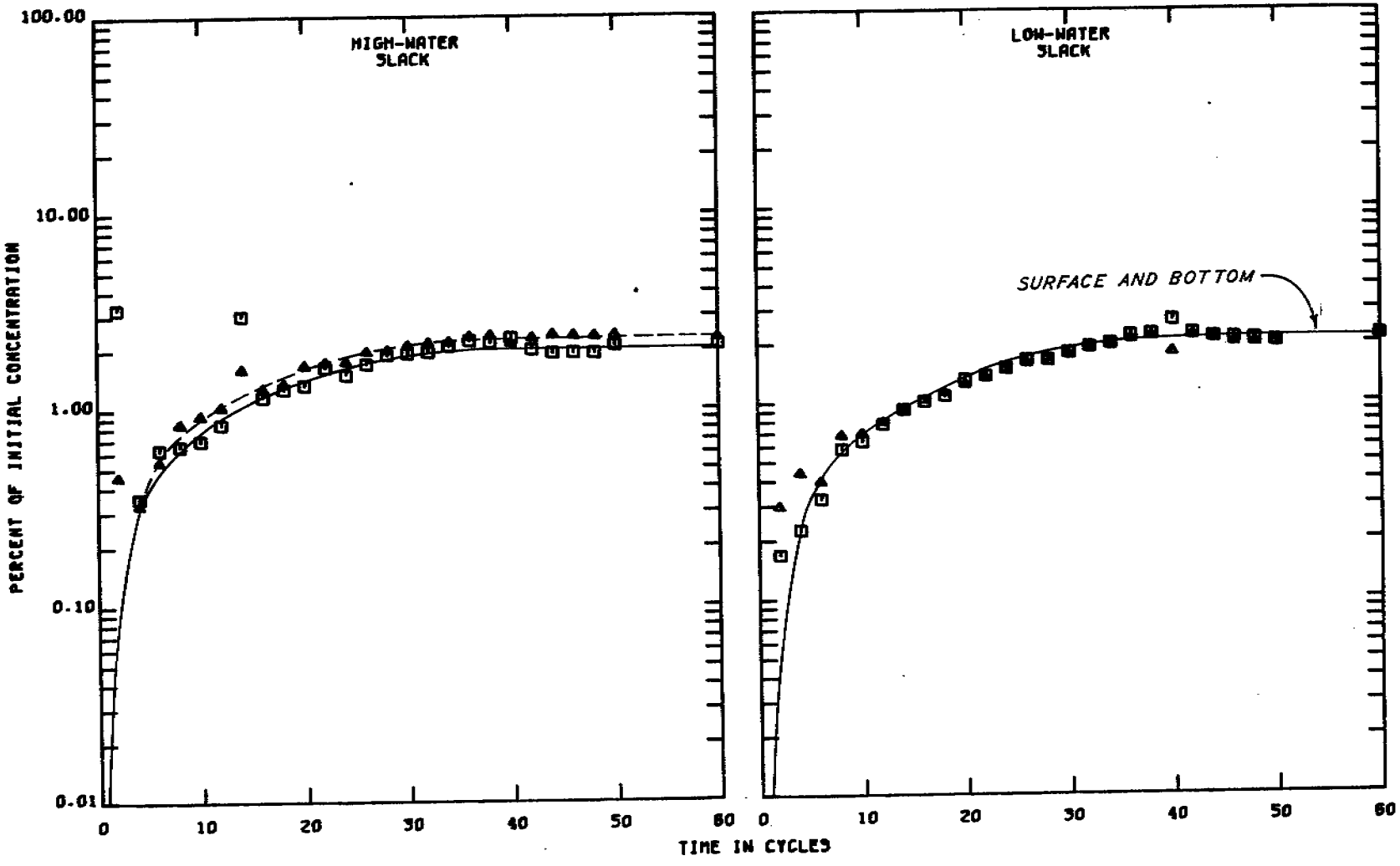
▲ – – – BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION G4



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

SAN DIEGO MODEL

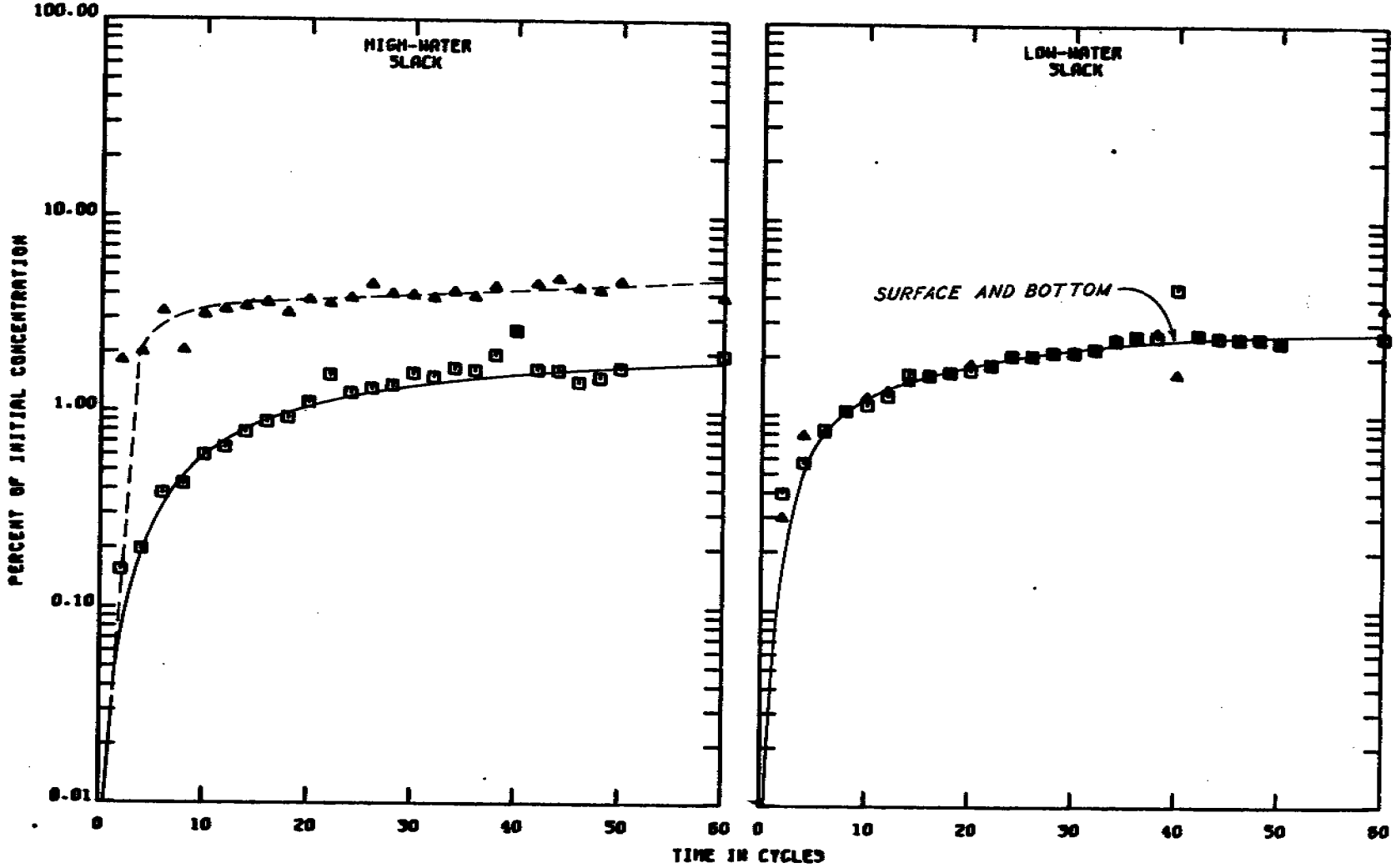
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION H1

PLATE 35

PLATE 36



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	8.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

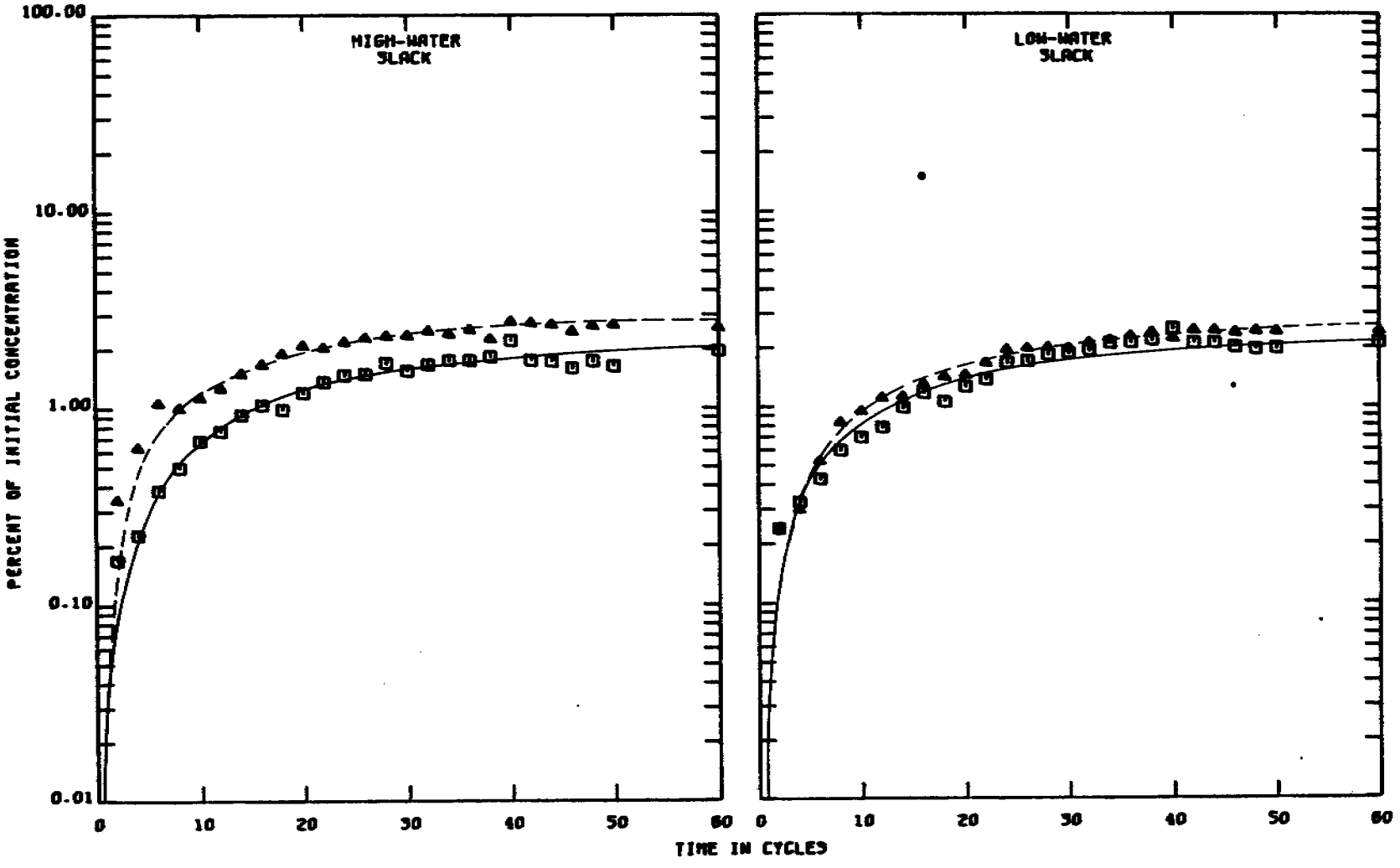
▲ - - - BOTTOM

SAN DIEGO MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION M2



TEST CONDITIONS

TIDAL RANGE AT BALLAST POINT	6.2 FT
OCEAN SALINITY (TOTAL SALT)	0.0 PPT
EFFLUENT CONCENTRATION	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

SAN DIEGO MODEL

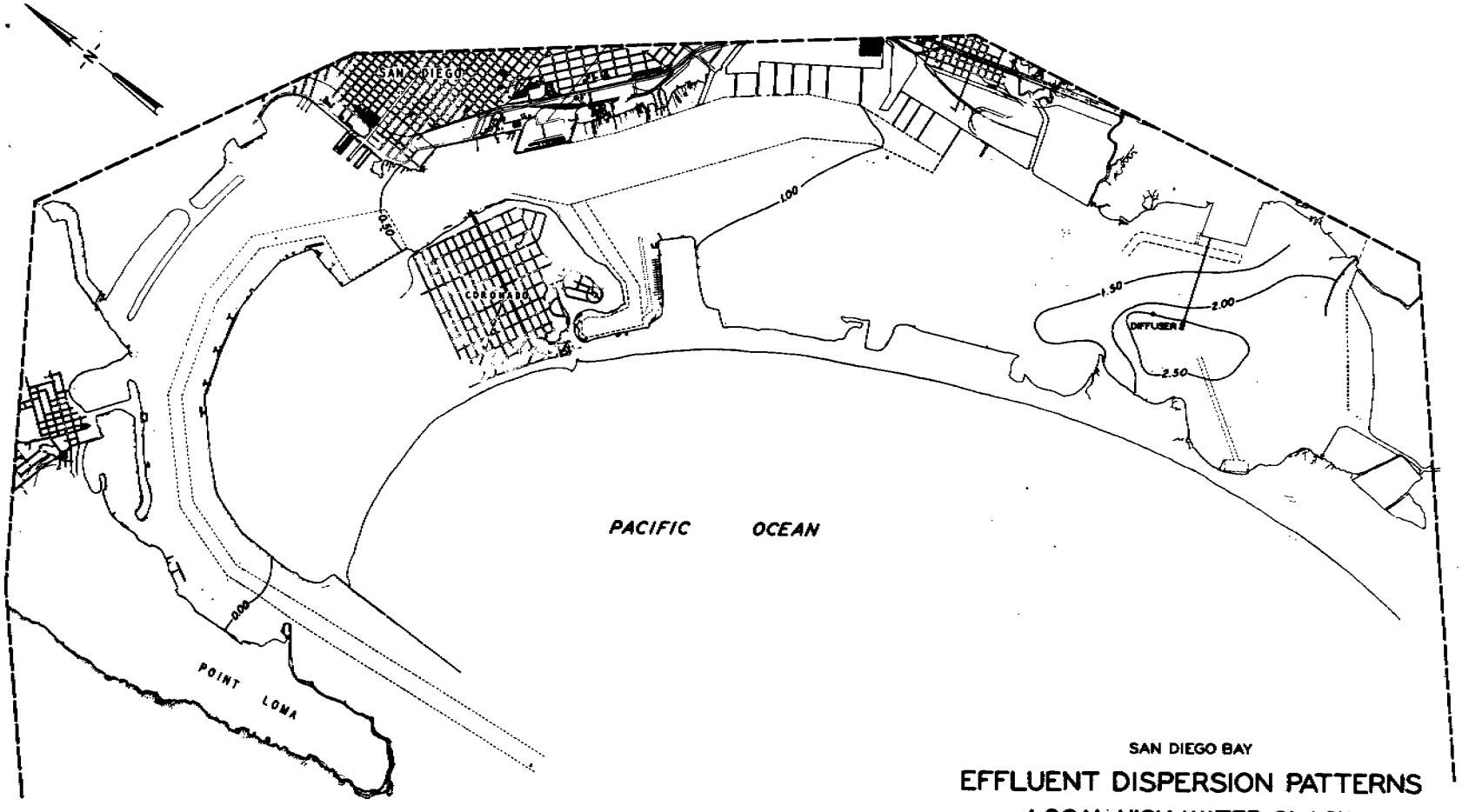
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION M3

PLATE 37

PLATE 38



NOTE: CONTOURS ARE IN PERCENT OF INITIAL EFFLUENT CONCENTRATION (11.4 PPT)

SAN DIEGO BAY

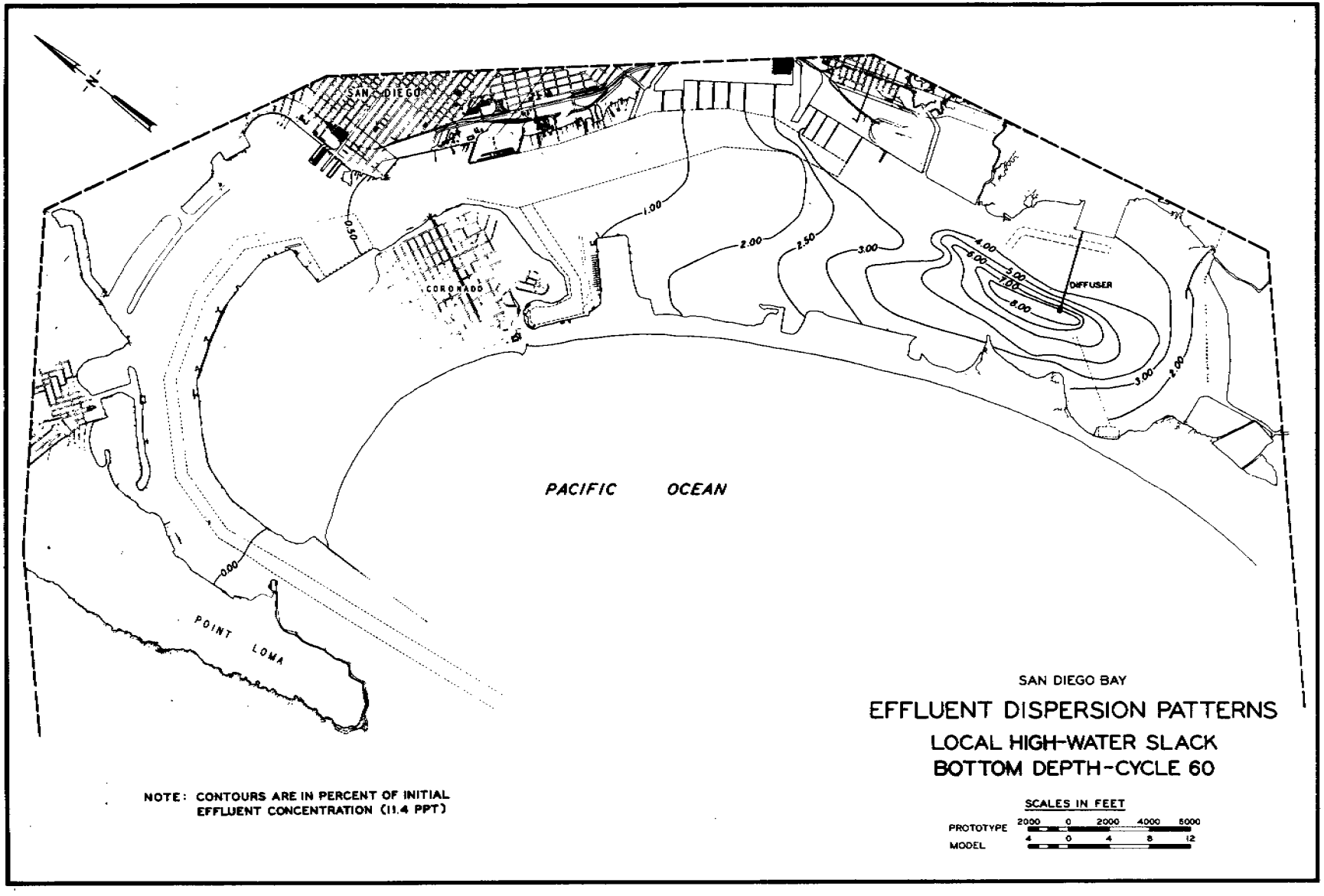
EFFLUENT DISPERSION PATTERNS

LOCAL HIGH-WATER SLACK

SURFACE DEPTH-CYCLE 60

SCALES IN FEET

PROTOTYPE	2000	0	2000	4000	6000
MODEL	4	0	4	8	12



NOTE: CONTOURS ARE IN PERCENT OF INITIAL EFFLUENT CONCENTRATION (11.4 PPT)

SAN DIEGO BAY

EFFLUENT DISPERSION PATTERNS

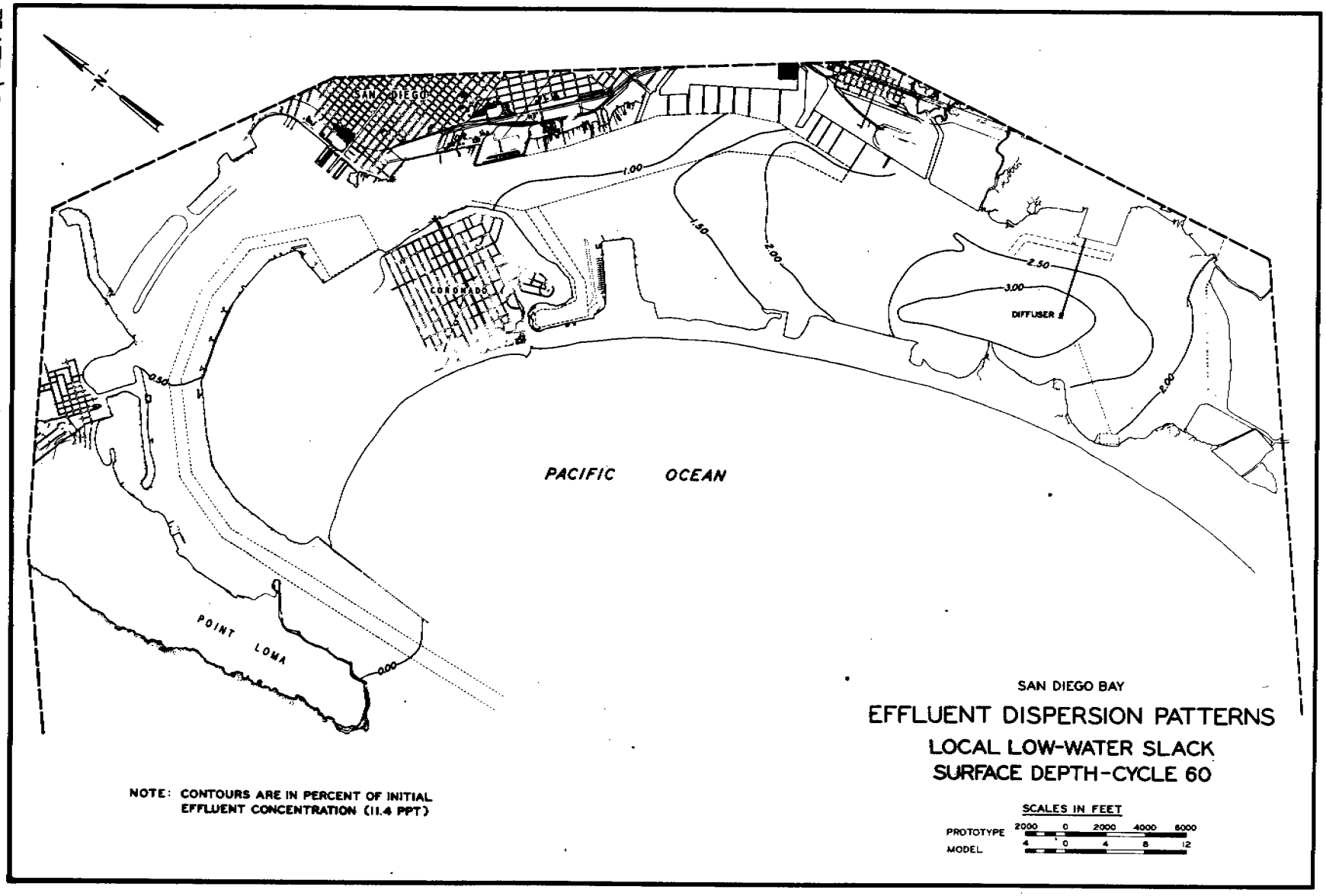
LOCAL HIGH-WATER SLACK
BOTTOM DEPTH-CYCLE 60

SCALES IN FEET

PROTOTYPE	2000	0	2000	4000	6000
MODEL	4	0	4	8	12

PLATE 39

PLATE 40



NOTE: CONTOURS ARE IN PERCENT OF INITIAL EFFLUENT CONCENTRATION (11.4 PPT)

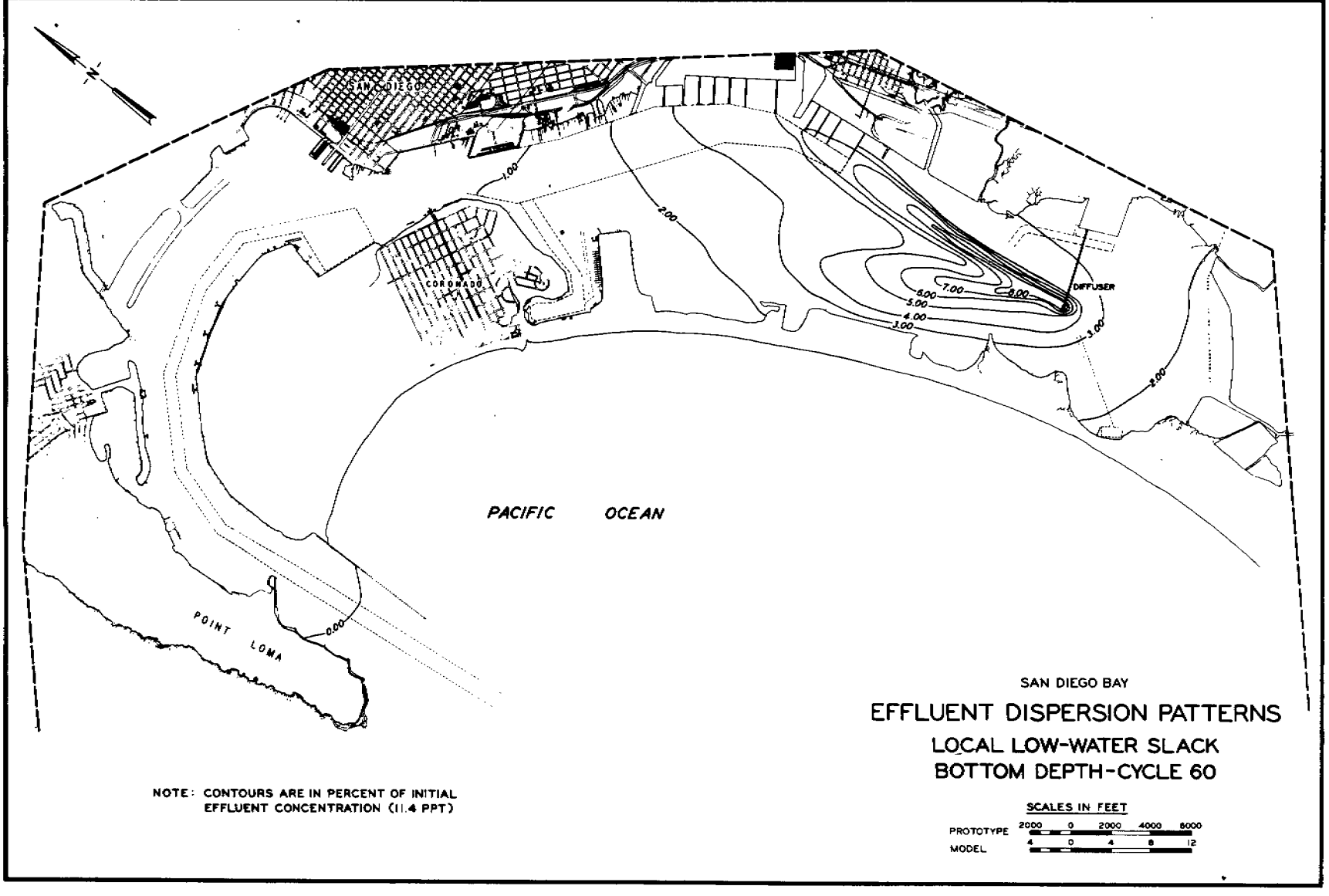
SAN DIEGO BAY

EFFLUENT DISPERSION PATTERNS

LOCAL LOW-WATER SLACK
SURFACE DEPTH-CYCLE 60

SCALES IN FEET

PROTOTYPE	2000	0	2000	4000	6000
MODEL	4	0	4	8	12



NOTE: CONTOURS ARE IN PERCENT OF INITIAL EFFLUENT CONCENTRATION (11.4 PPT)

SAN DIEGO BAY

EFFLUENT DISPERSION PATTERNS

LOCAL LOW-WATER SLACK

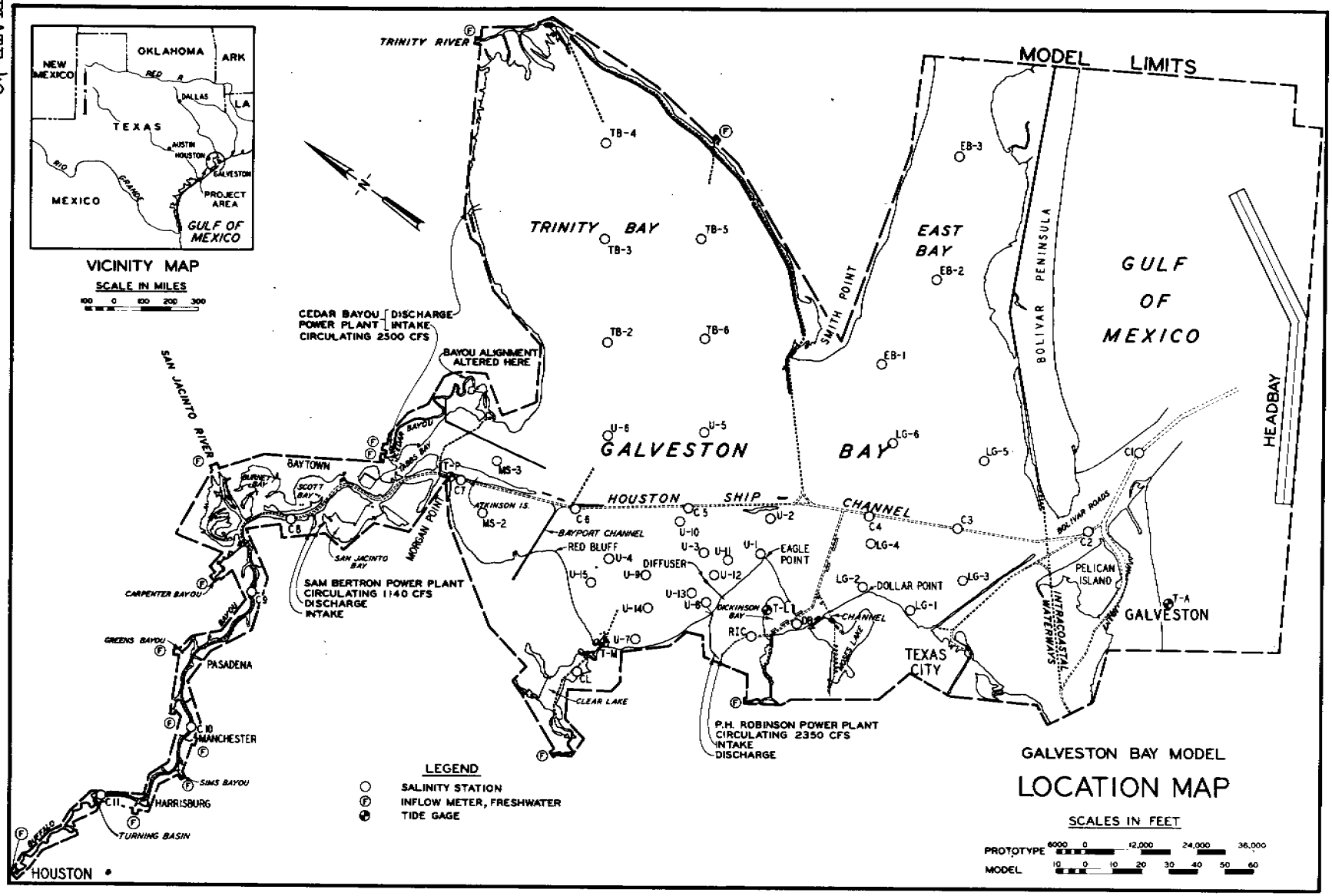
BOTTOM DEPTH-CYCLE 60

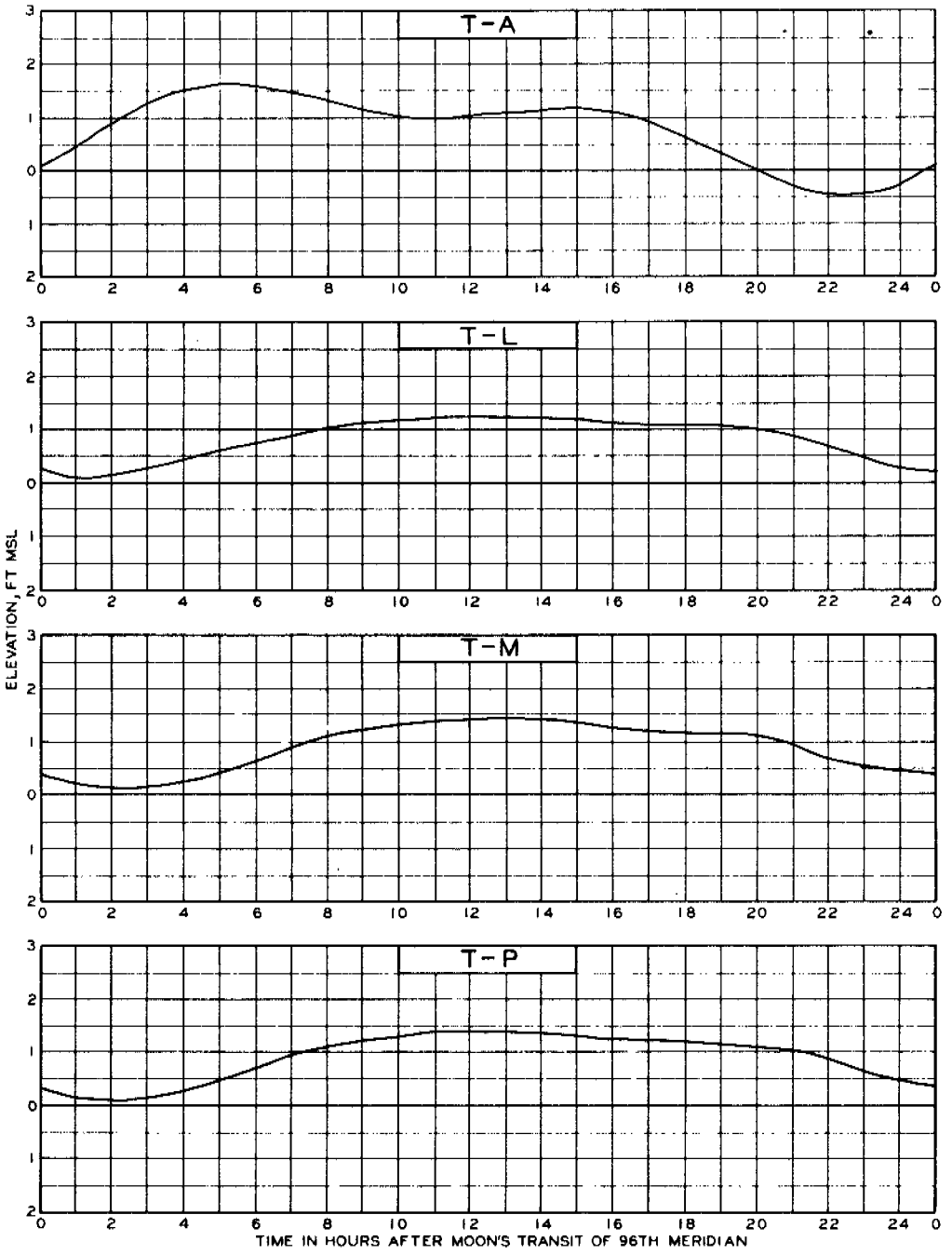
SCALES IN FEET

PROTOTYPE	2000	0	2000	4000	6000
MODEL	4	0	4	8	12

PLATE 41

PLATE 42


VICINITY MAP
SCALE IN MILES
100 0 100 200 300
NEW MEXICO
OKLAHOMA
ARK
LA
TEXAS
MEXICO
RED R
DALLAS
AUSTIN
HOUSTON
GALVESTON
RIO GRANDE
PROJECT AREA
GULF OF MEXICO
TRINITY RIVER
TRINITY BAY
EAST BAY
GALVESTON BAY
GULF OF MEXICO
MODEL LIMITS
SMITH POINT
BOLIVAR PENINSULA
HEADBAY
BAYTOWN
SAN JACINTO RIVER
BUFFALO BAYOU
SCOTT BAY
BURNET BAY
SAN JACINTO BAY
MORGAN POINT
ATKINSON IS.
HOUSTON SHIP CHANNEL
BAYPORT CHANNEL
RED BLUFF
DIFFUSER
EAGLE POINT
DOLLAR POINT
DICKINSON BAY
CLEAR LAKE
TEXAS CITY
PELICAN ISLAND
INTRACOASTAL WATERWAYS
GALVESTON
CEDAR BAYOU POWER PLANT CIRCULATING 2500 CFS DISCHARGE INTAKE
BAYOU ALIGNMENT ALTERED HERE
SAM BERTRON POWER PLANT CIRCULATING 1140 CFS DISCHARGE INTAKE
P.H. ROBINSON POWER PLANT CIRCULATING 2350 CFS INTAKE DISCHARGE
CARPENTER BAYOU
GREENS BAYOU
PASADENA
MANCHESTER
SIMS BAYOU
HARRISBURG
TURNING BASIN
HOUSTON
LEGEND
SALINITY STATION
INFLOW METER, FRESHWATER
TIDE GAGE
GALVESTON BAY MODEL
LOCATION MAP
SCALES IN FEET
PROTOTYPE 6000 0 12,000 24,000 36,000
MODEL 10 0 10 20 30 40 50 60



MODEL TEST DATA

TIDE . . . . . MEAN
FRESH-WATER DISCHARGE 11,323 CFS
SOURCE SALINITY. 32.5PPT

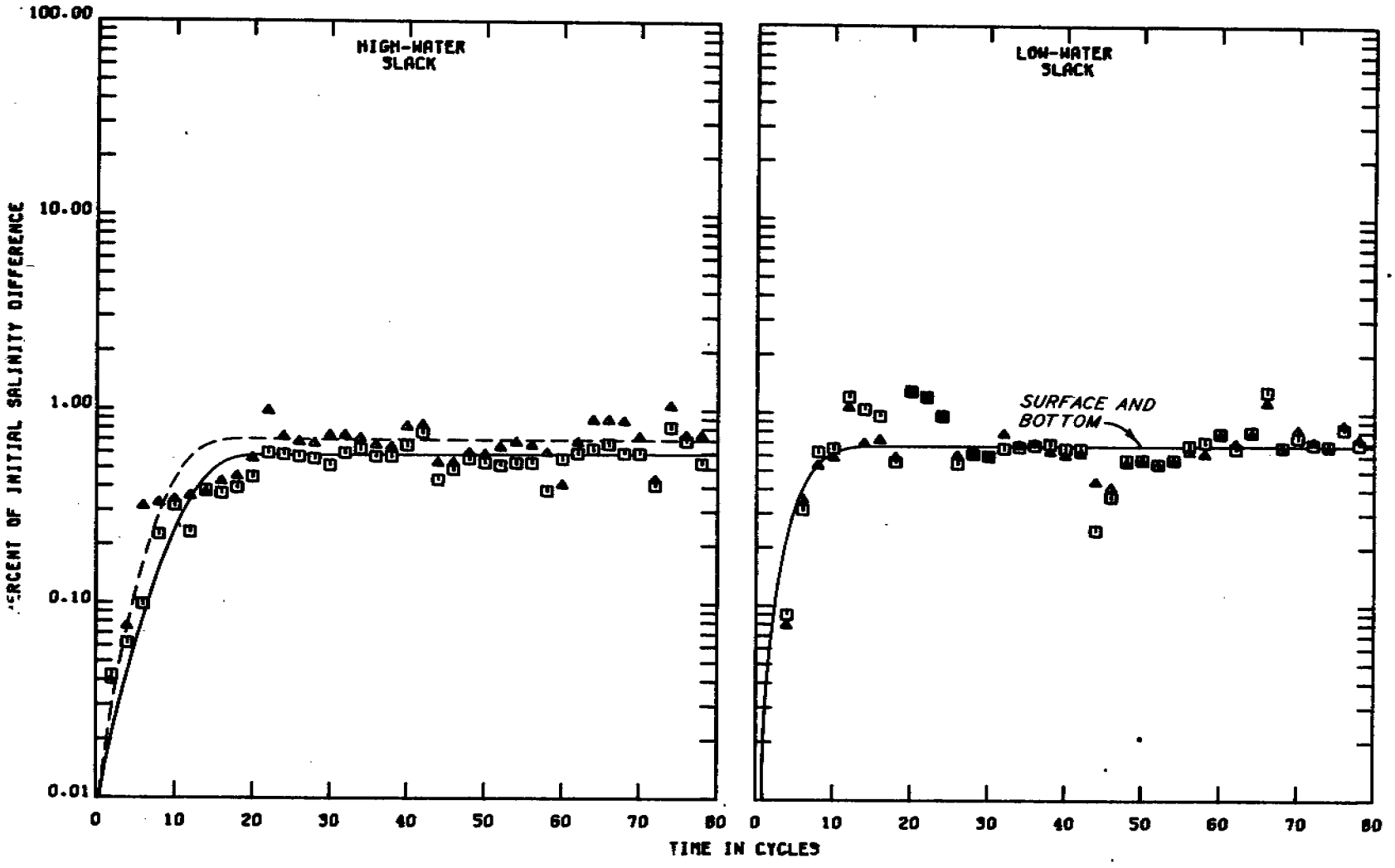
GALVESTON BAY MODEL

TIDAL OBSERVATIONS

STATIONS T-A, T-L,
T-M, AND T-P

PLATE 43

PLATE 44



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

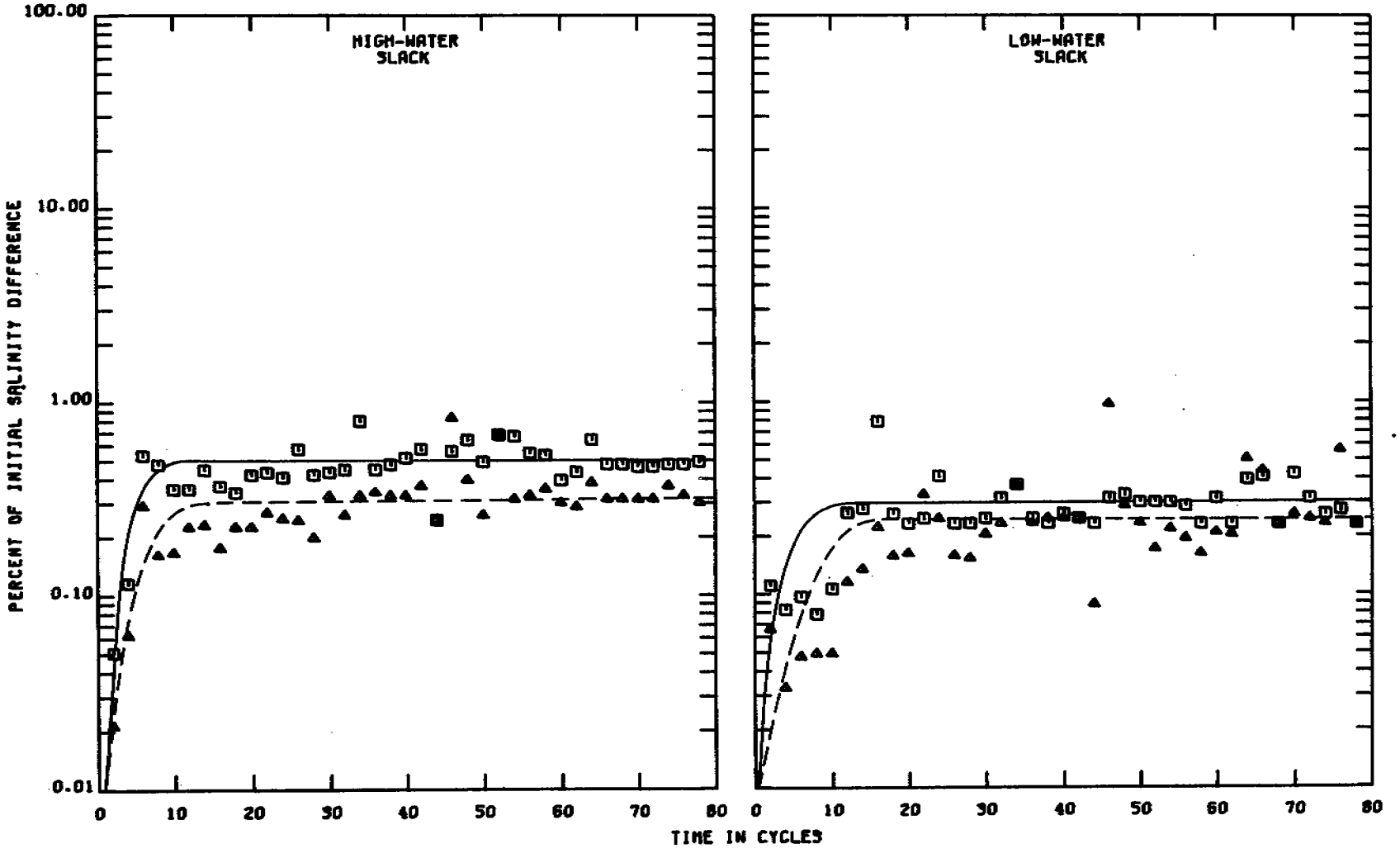
▲ - - - BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U1



TEST CONDITIONS

FRESH-WATER DISCHARGE	11325 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

GALVESTON BAY MODEL

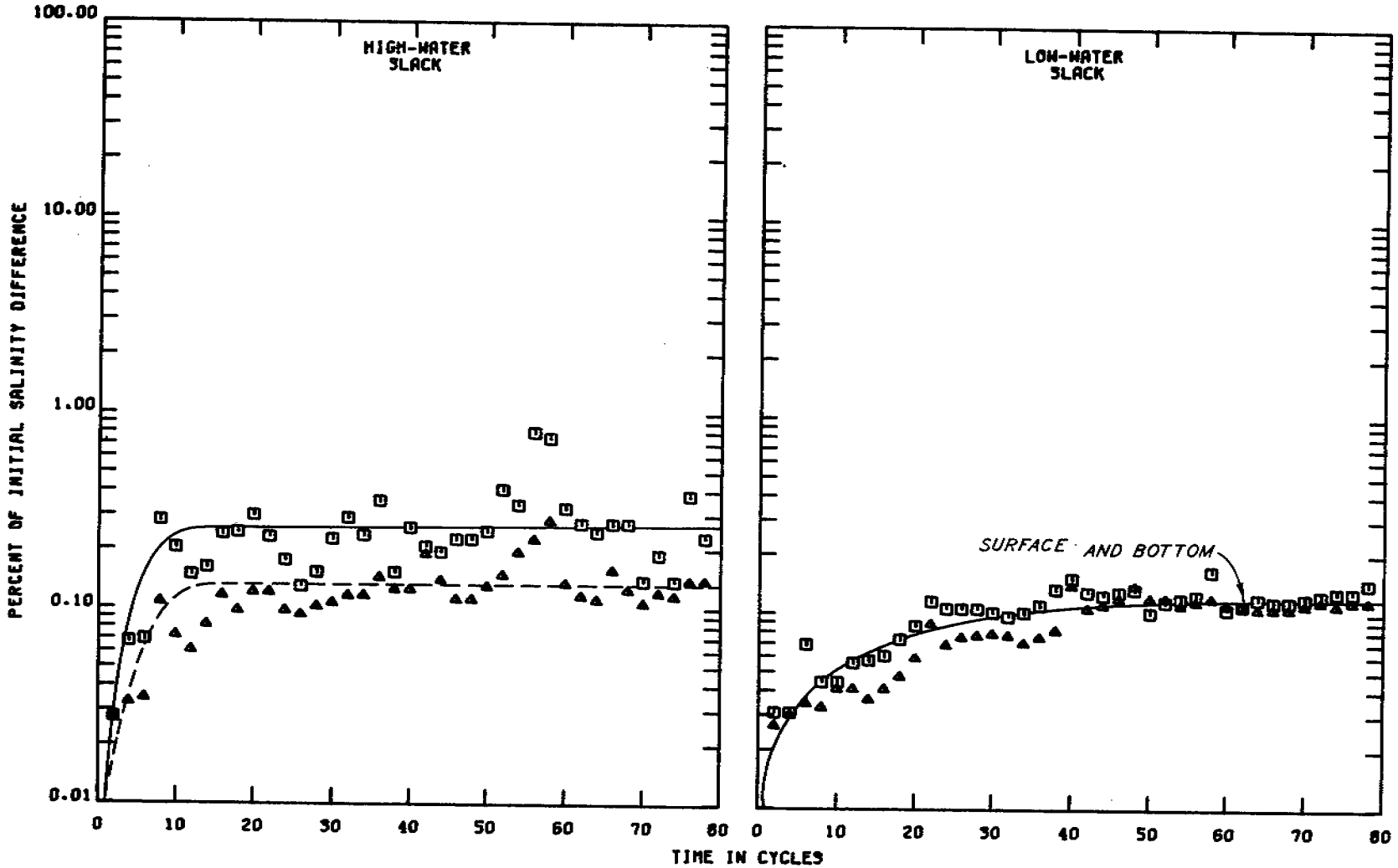
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U2

PLATE 45

PLATE 46



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

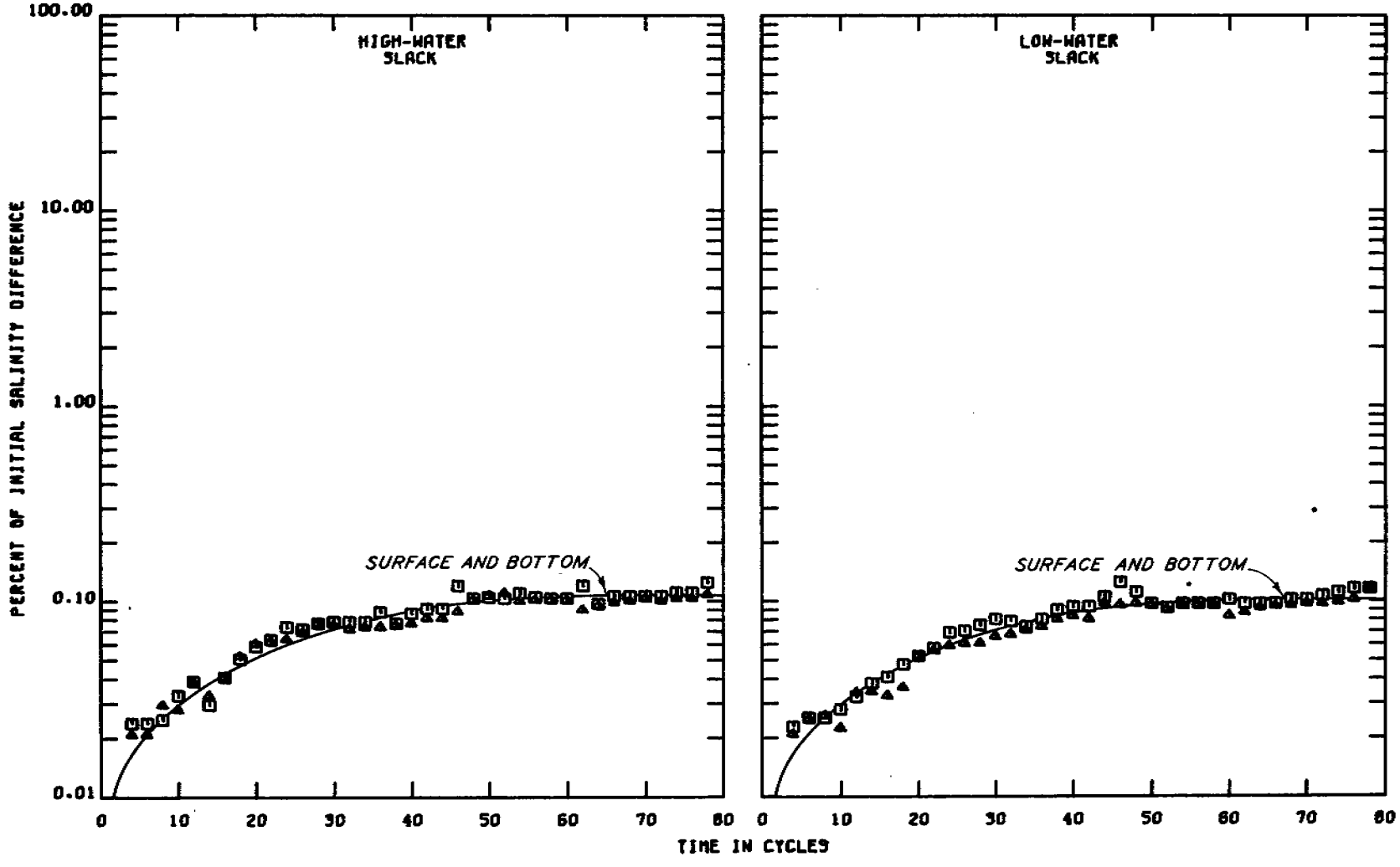
BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U9



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ — — — BOTTOM

GALVESTON BAY MODEL

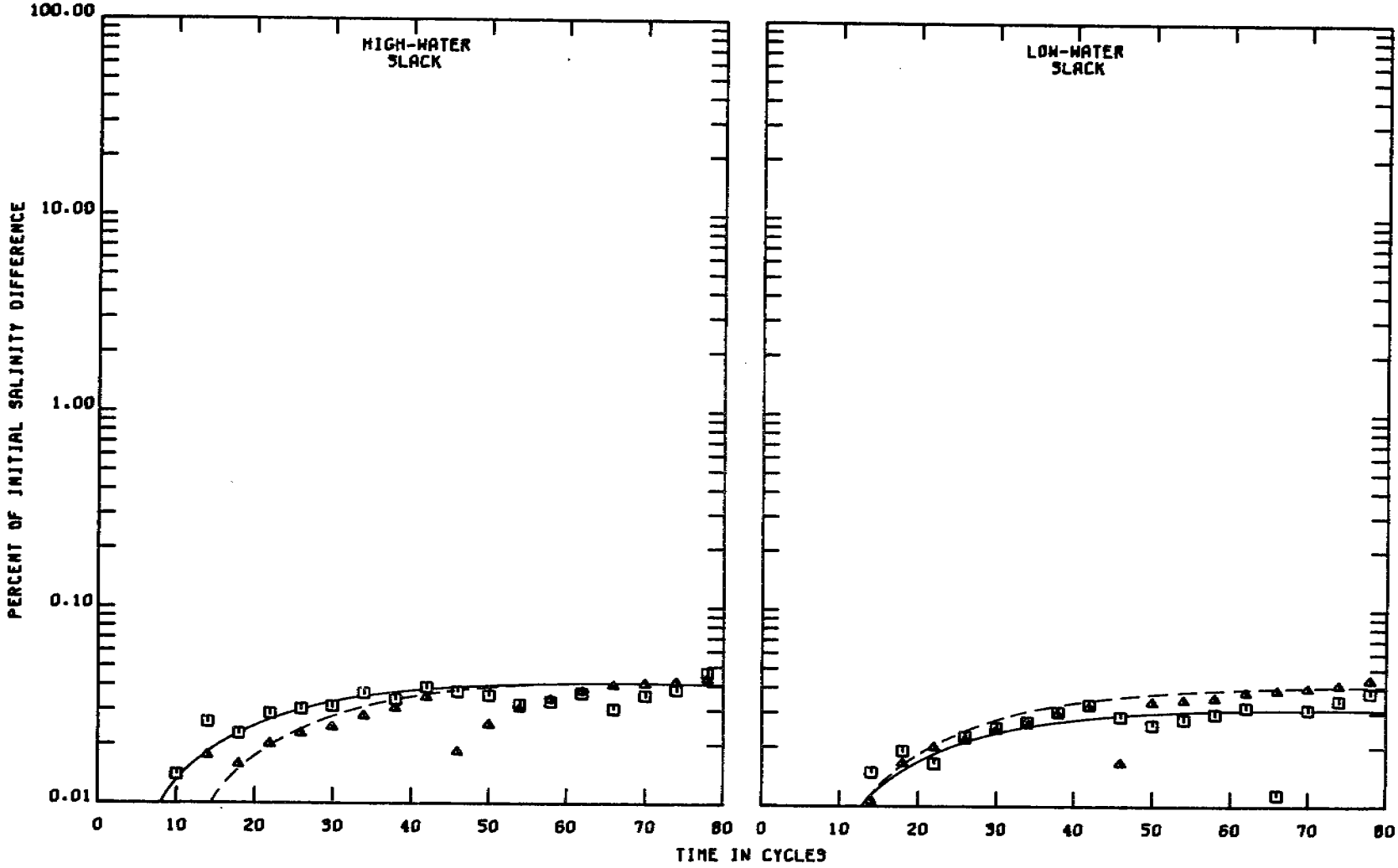
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U4

PLATE 47

PLATE 48



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

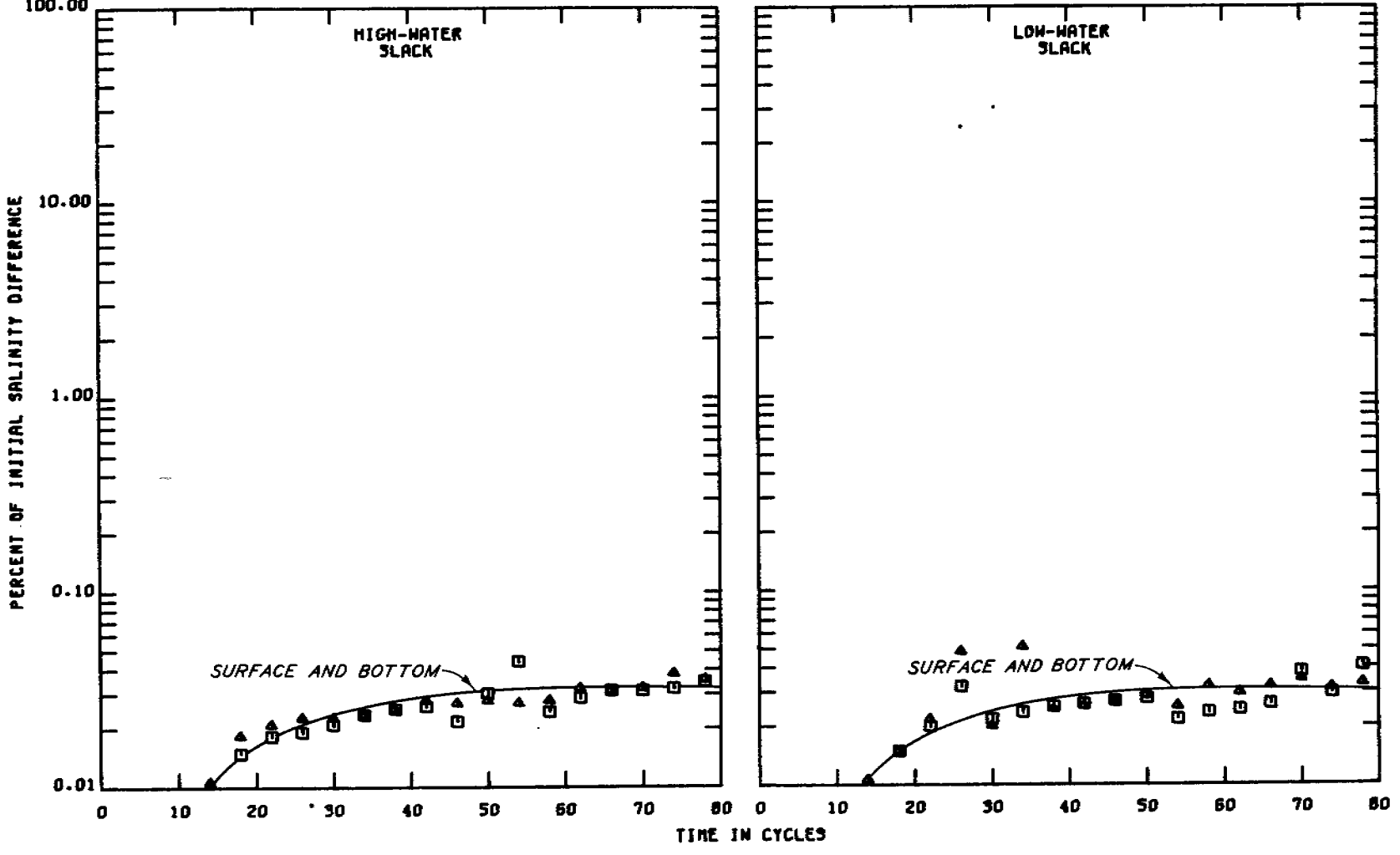
△ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U5



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ — — — BOTTOM

GALVESTON BAY MODEL

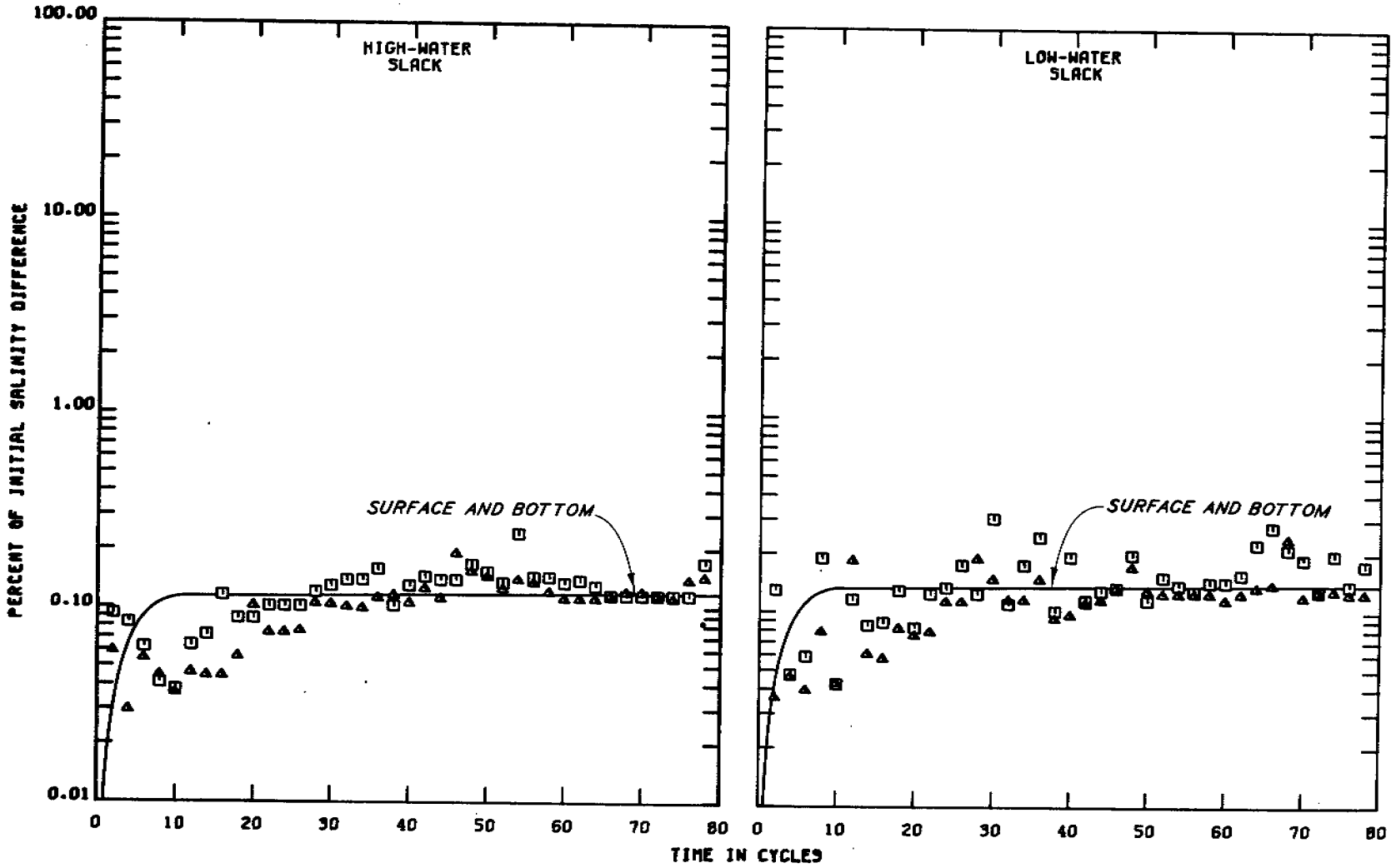
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U6

PLATE 49

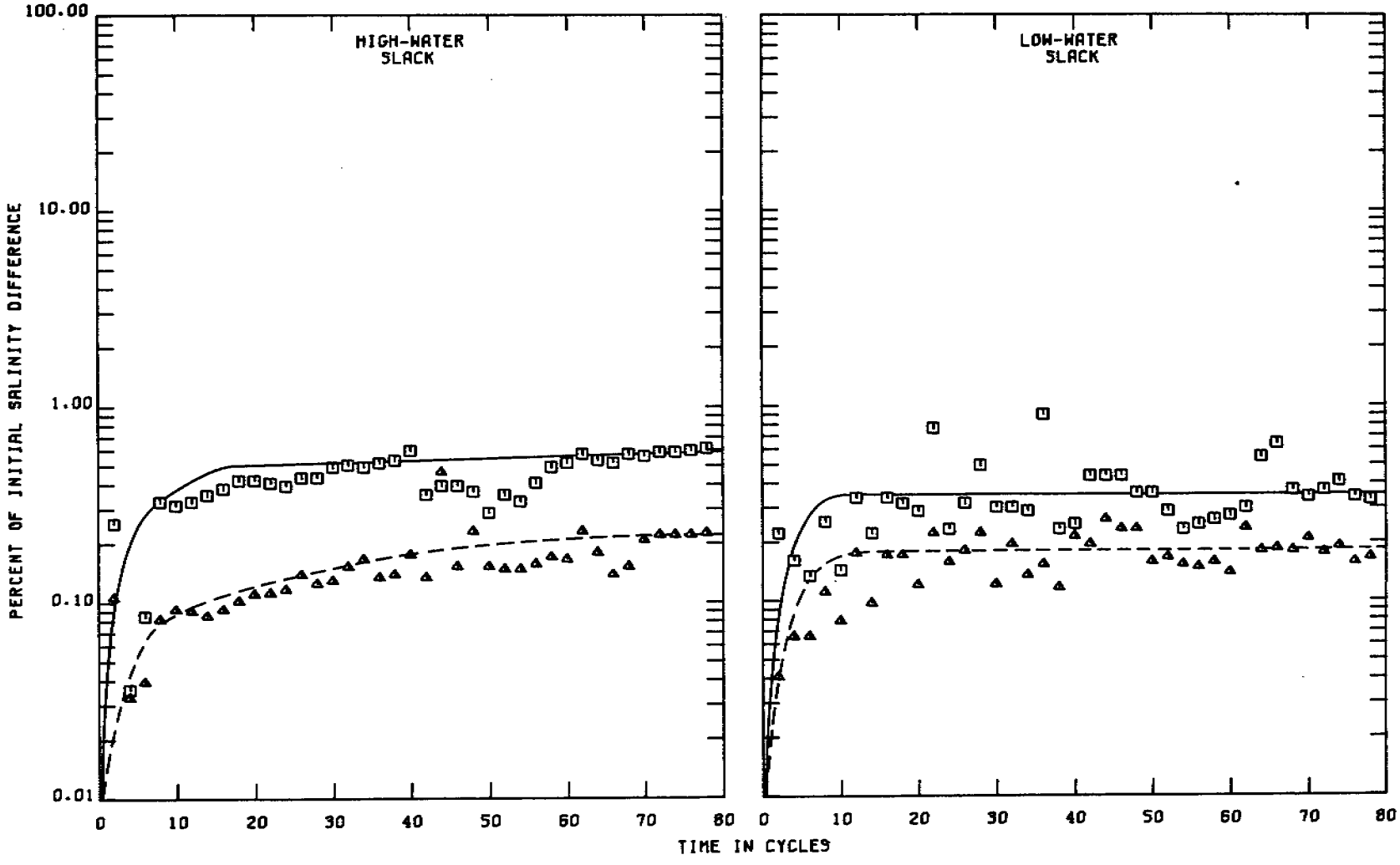
PLATE 50



TEST CONDITIONS	
FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND
SURFACE
BOTTOM

GALVESTON BAY MODEL
SALINE WATER DISPERSION TEST
10 MGD PLANT



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

GALVESTON BAY MODEL

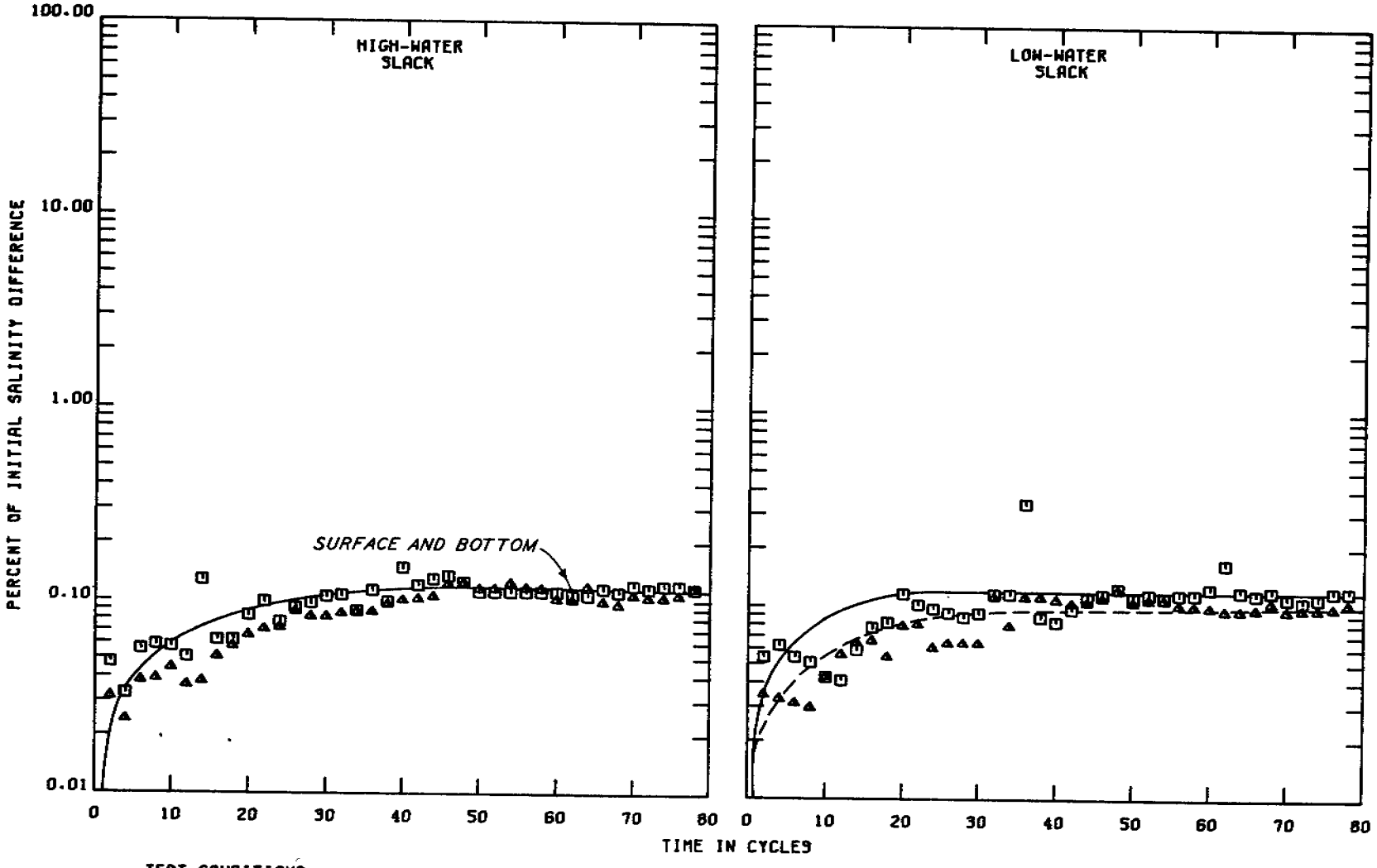
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U8

PLATE 51

PLATE 52



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

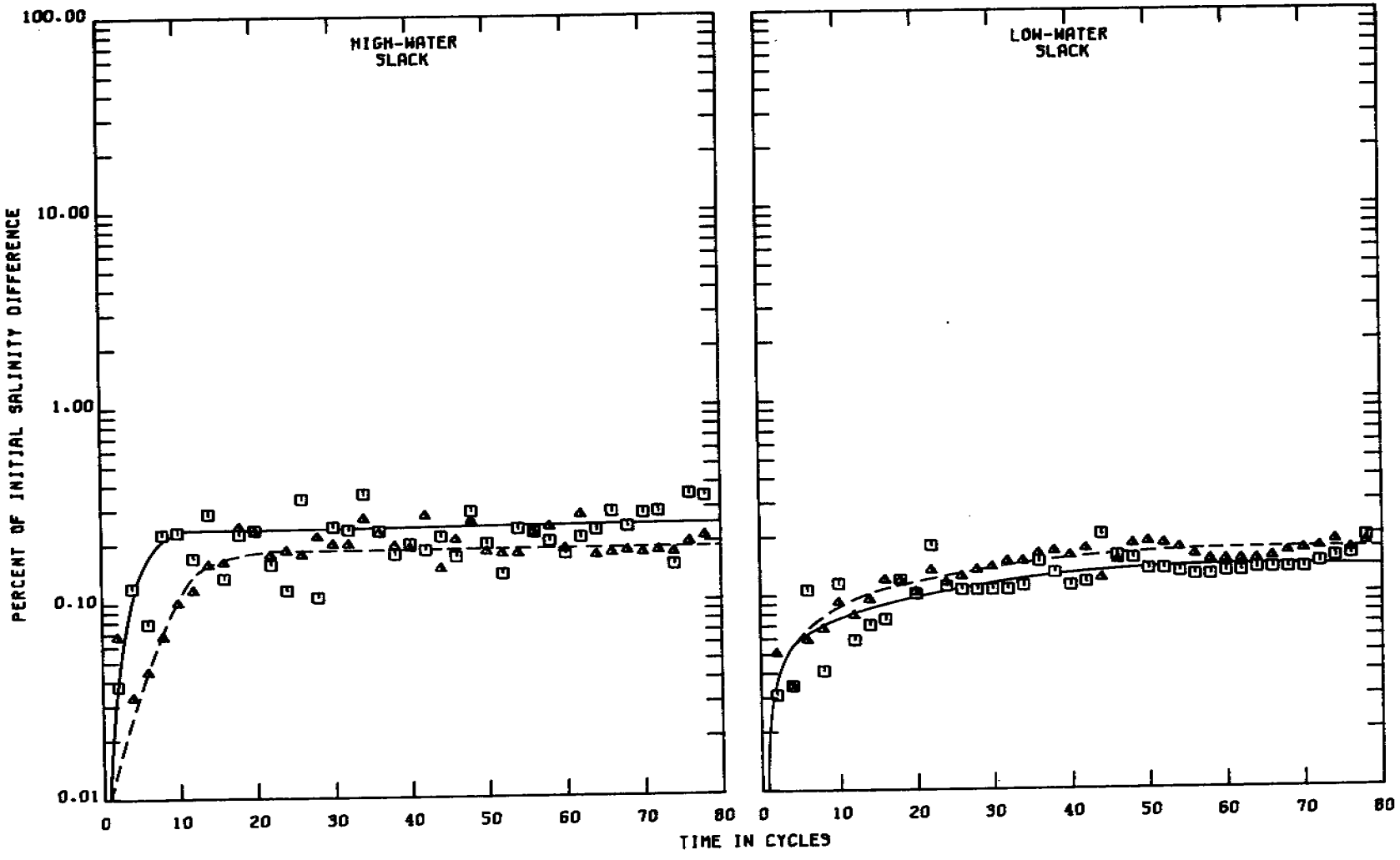
△ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U9



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

GALVESTON BAY MODEL

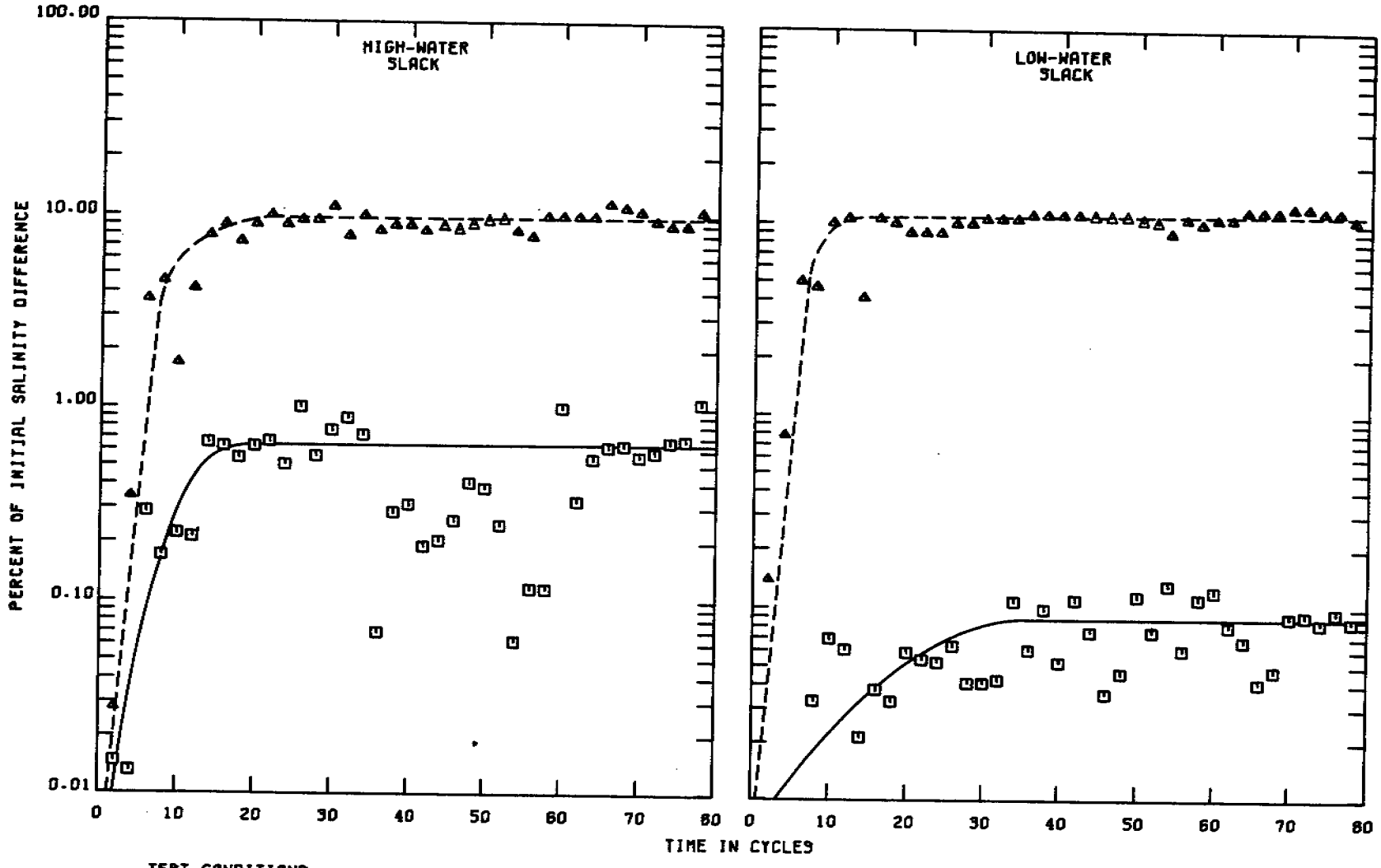
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U10

PLATE 53

PLATE 54



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

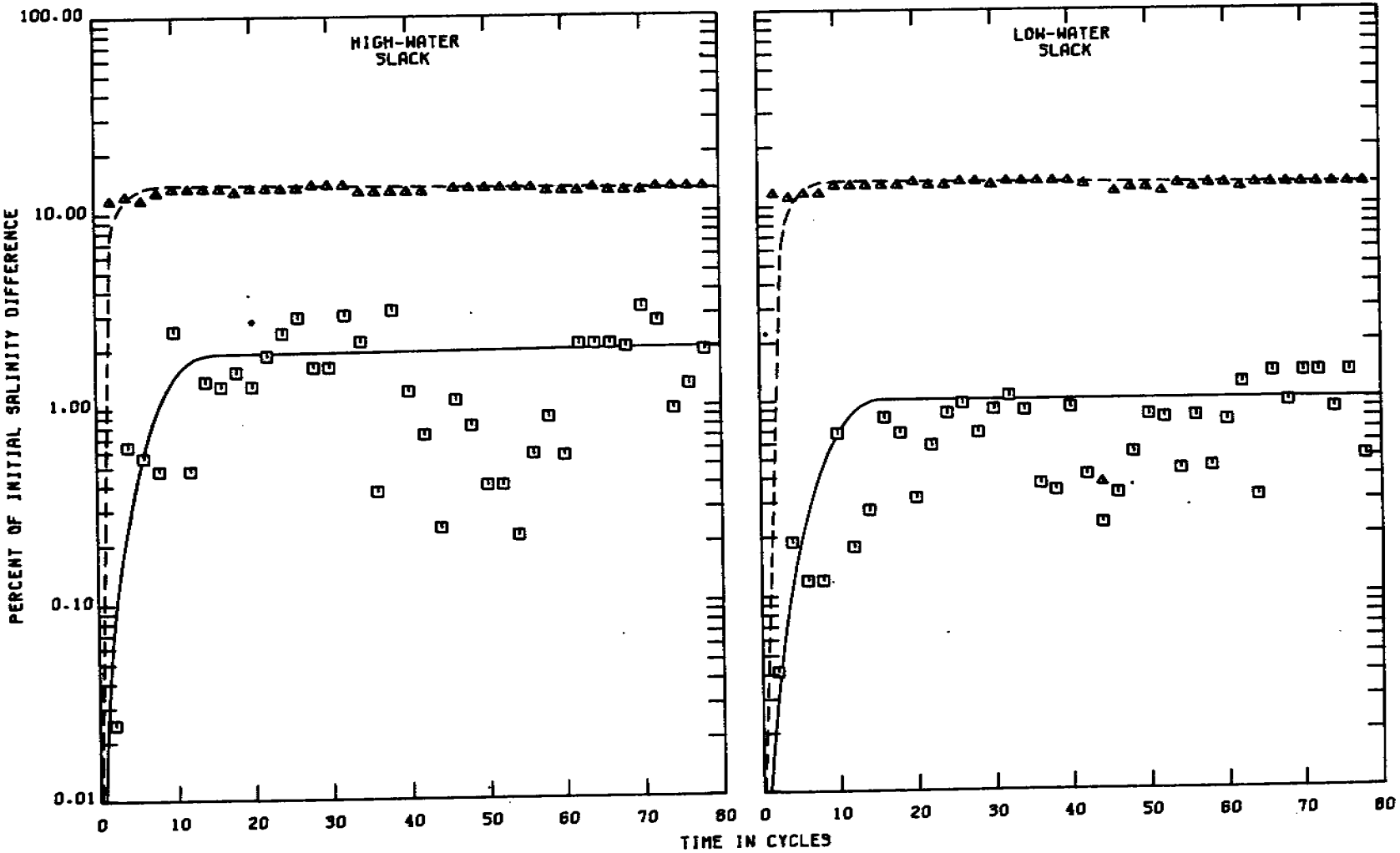
△ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U11



TEST CONDITIONS	
FRESH-WATER DISCHARGE	11923 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	91.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

GALVESTON BAY MODEL

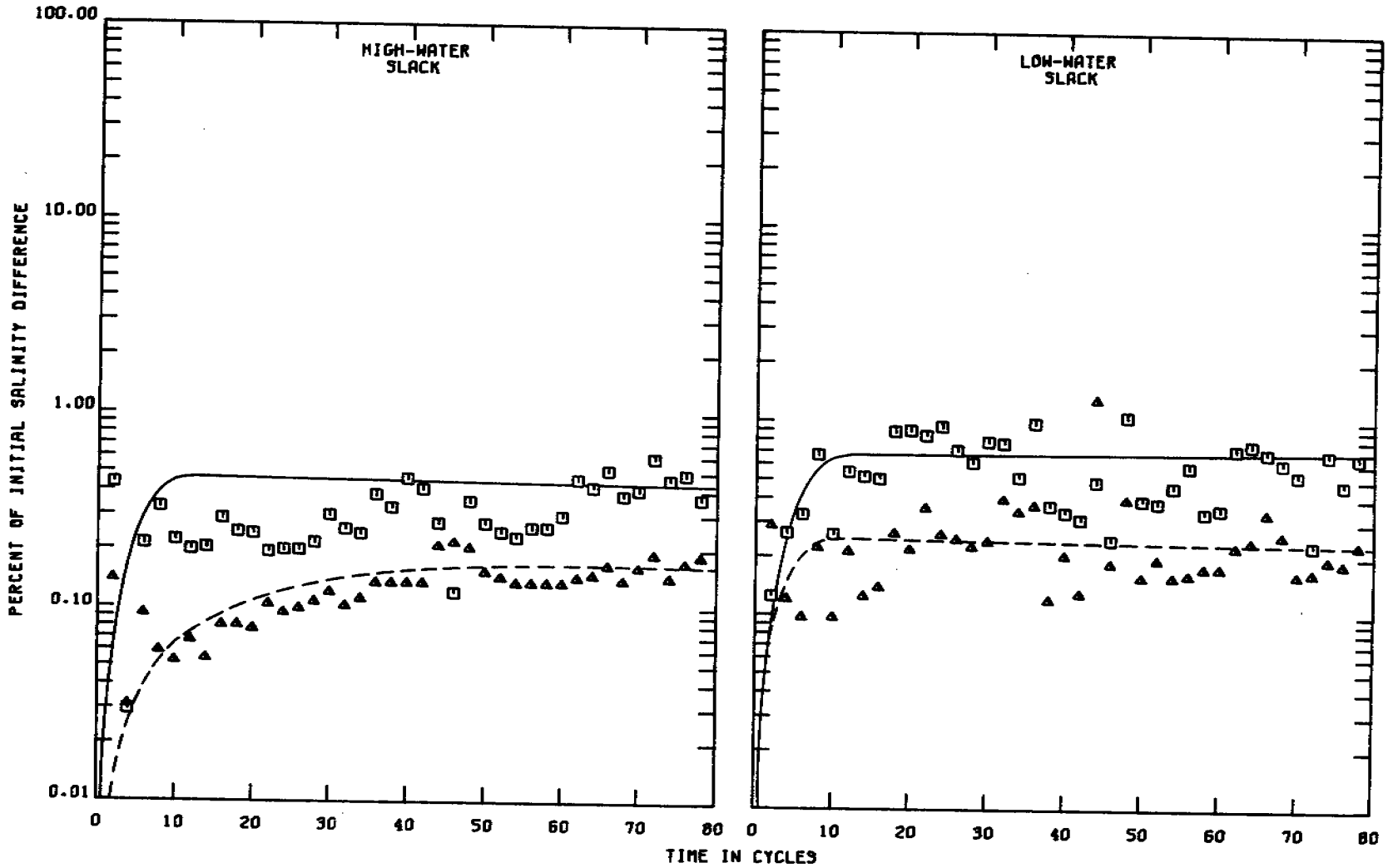
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U12

PLATE 55

PLATE 56



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	91.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

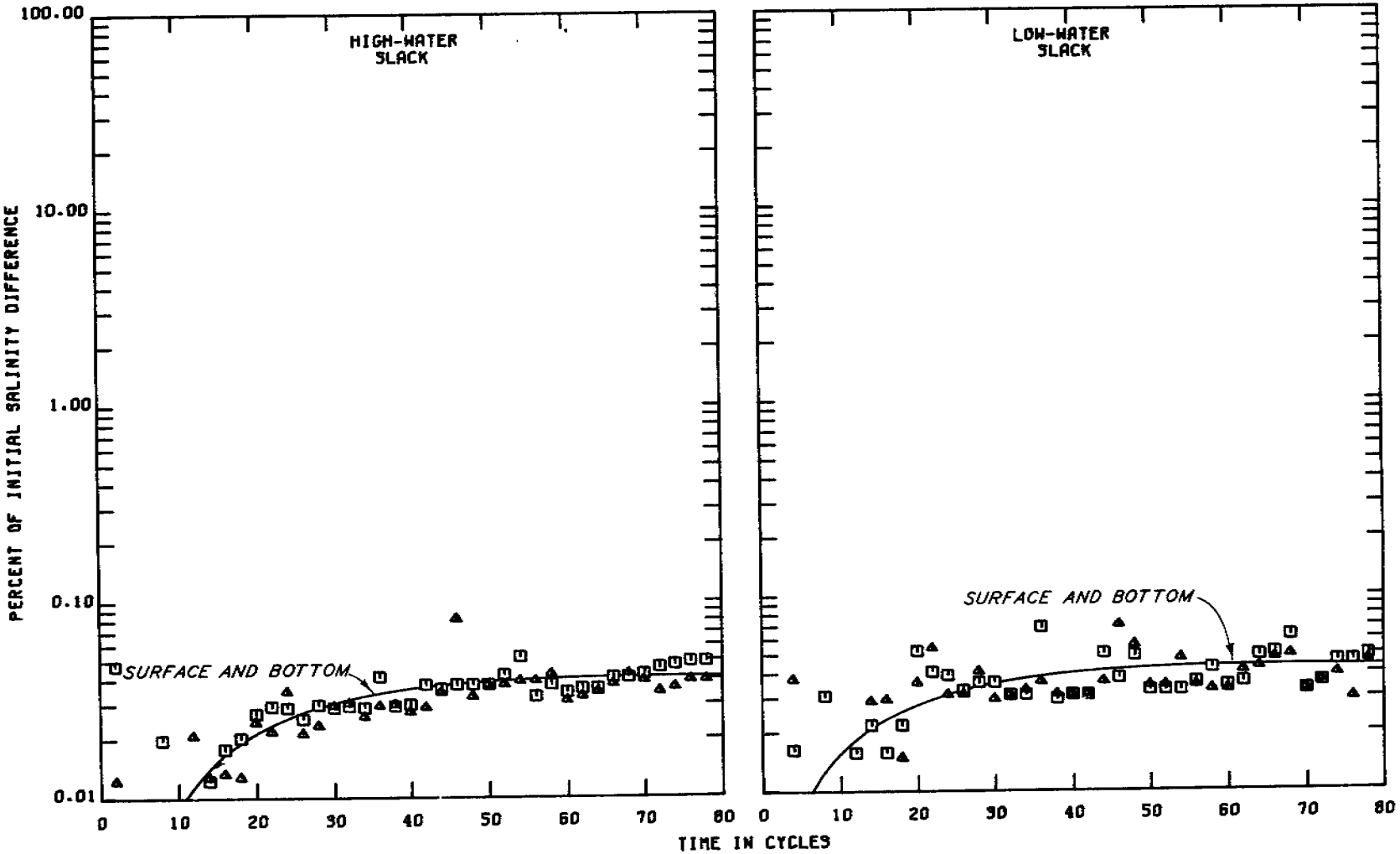
△ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U13



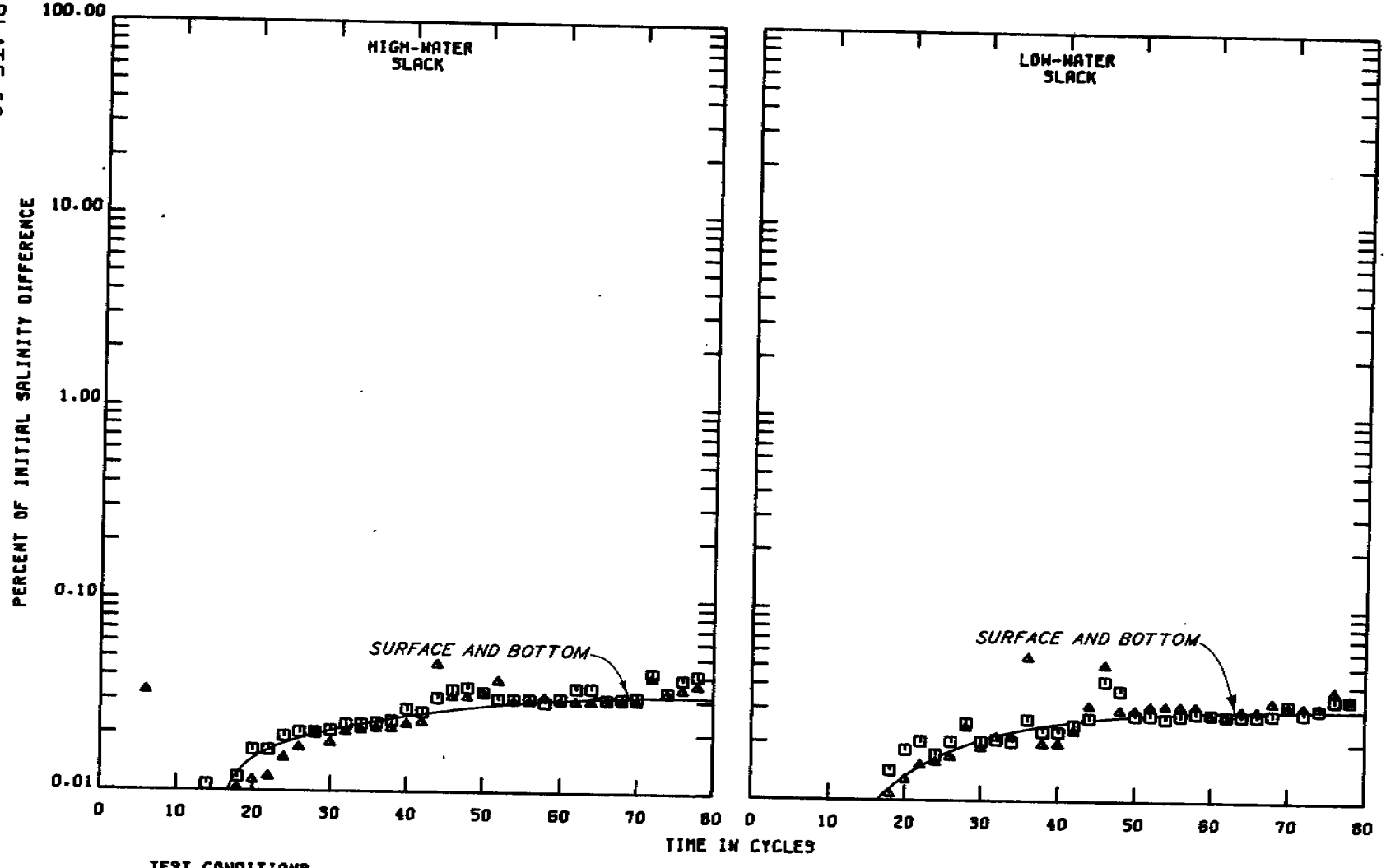
TEST CONDITIONS	
FRESH-WATER DISCHARGE	11923 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND
□ —— SURFACE
△ - - - BOTTOM

GALVESTON BAY MODEL
SALINE WATER DISPERSION TEST
10 MGD PLANT
STATION U14

PLATE 57

PLATE 58



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

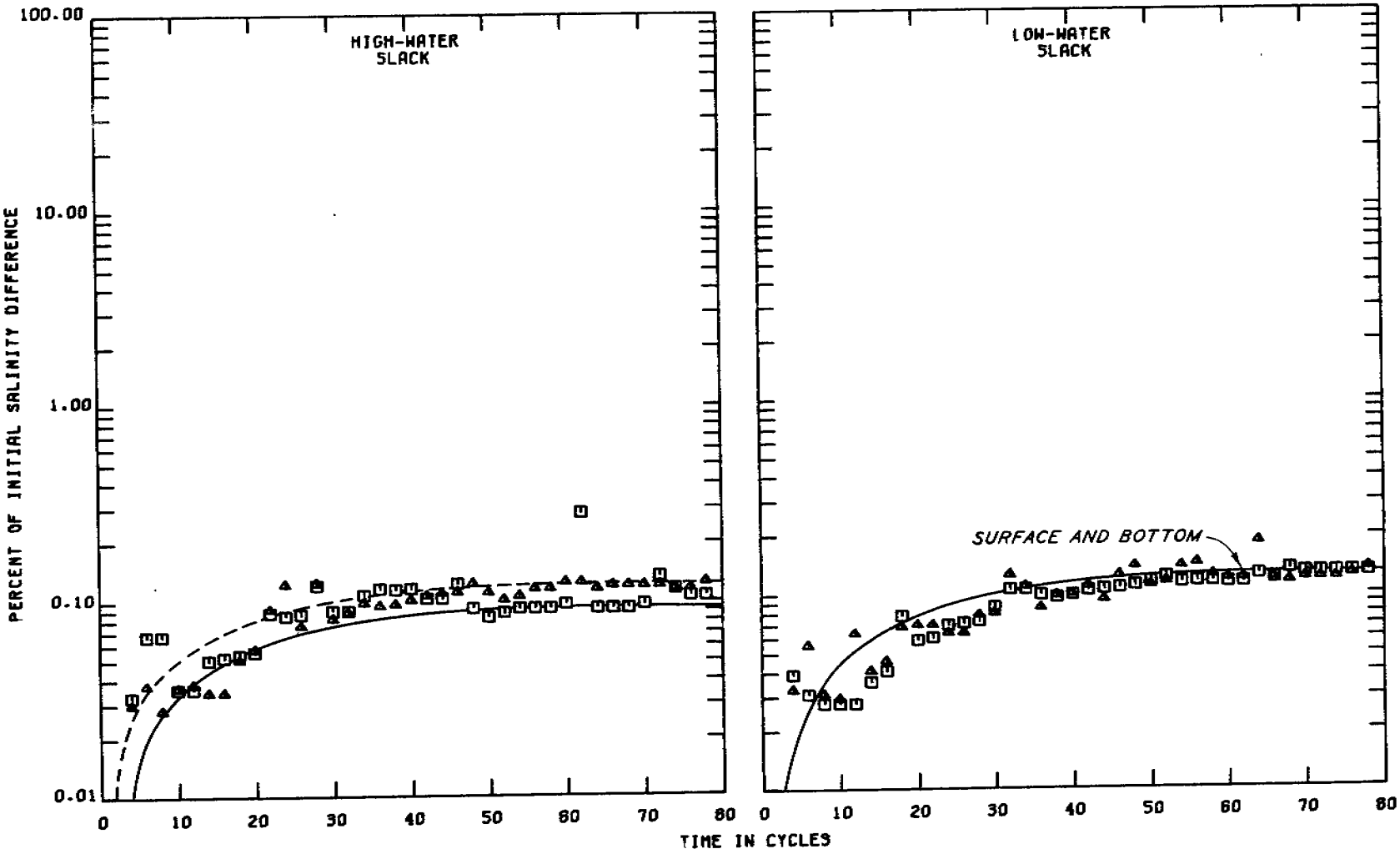
BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION U15



TEST CONDITIONS

FRESH-WATER DISCHARGE	11329 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

GALVESTON BAY MODEL

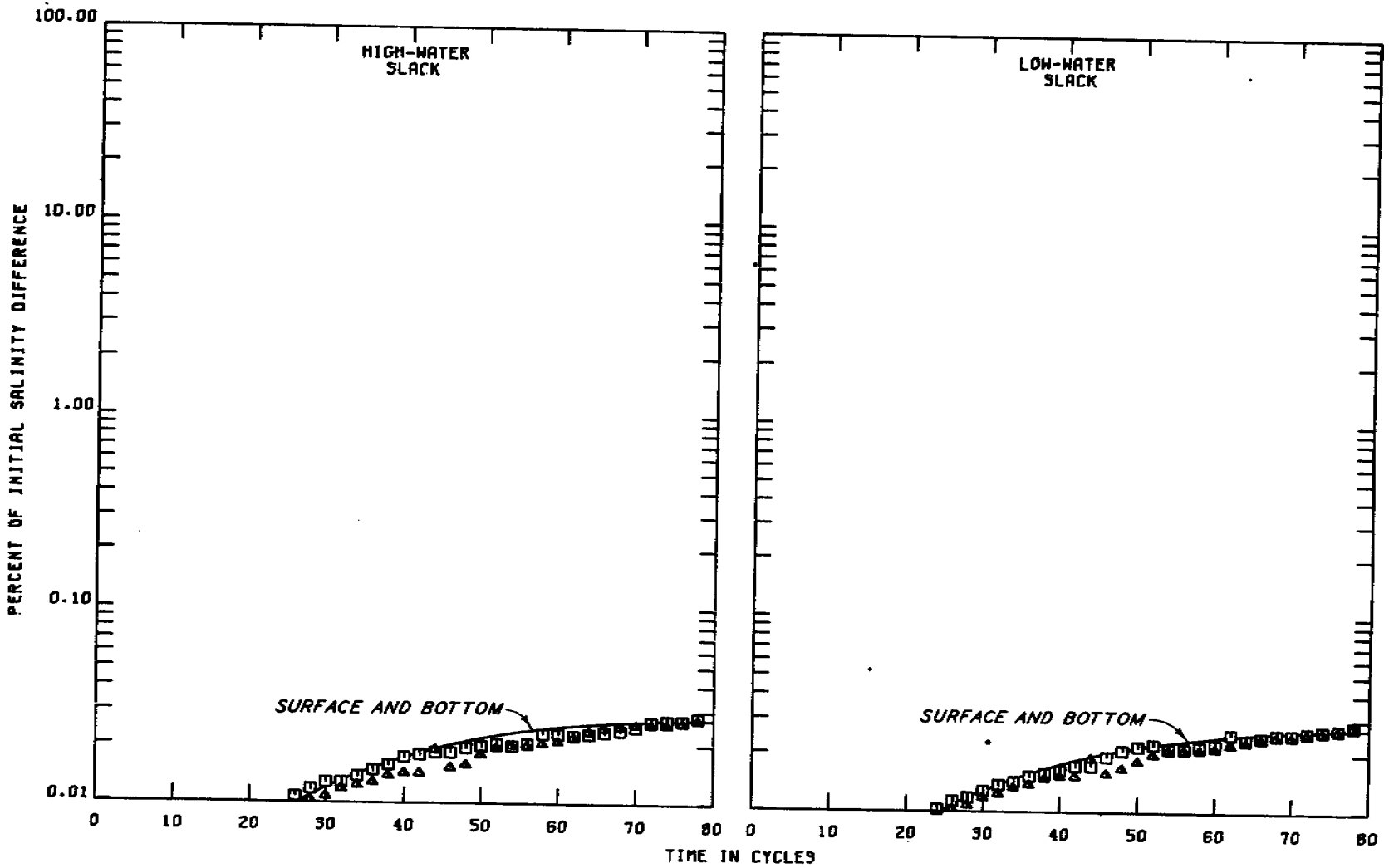
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION CL

PLATE 59

PLATE 60



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

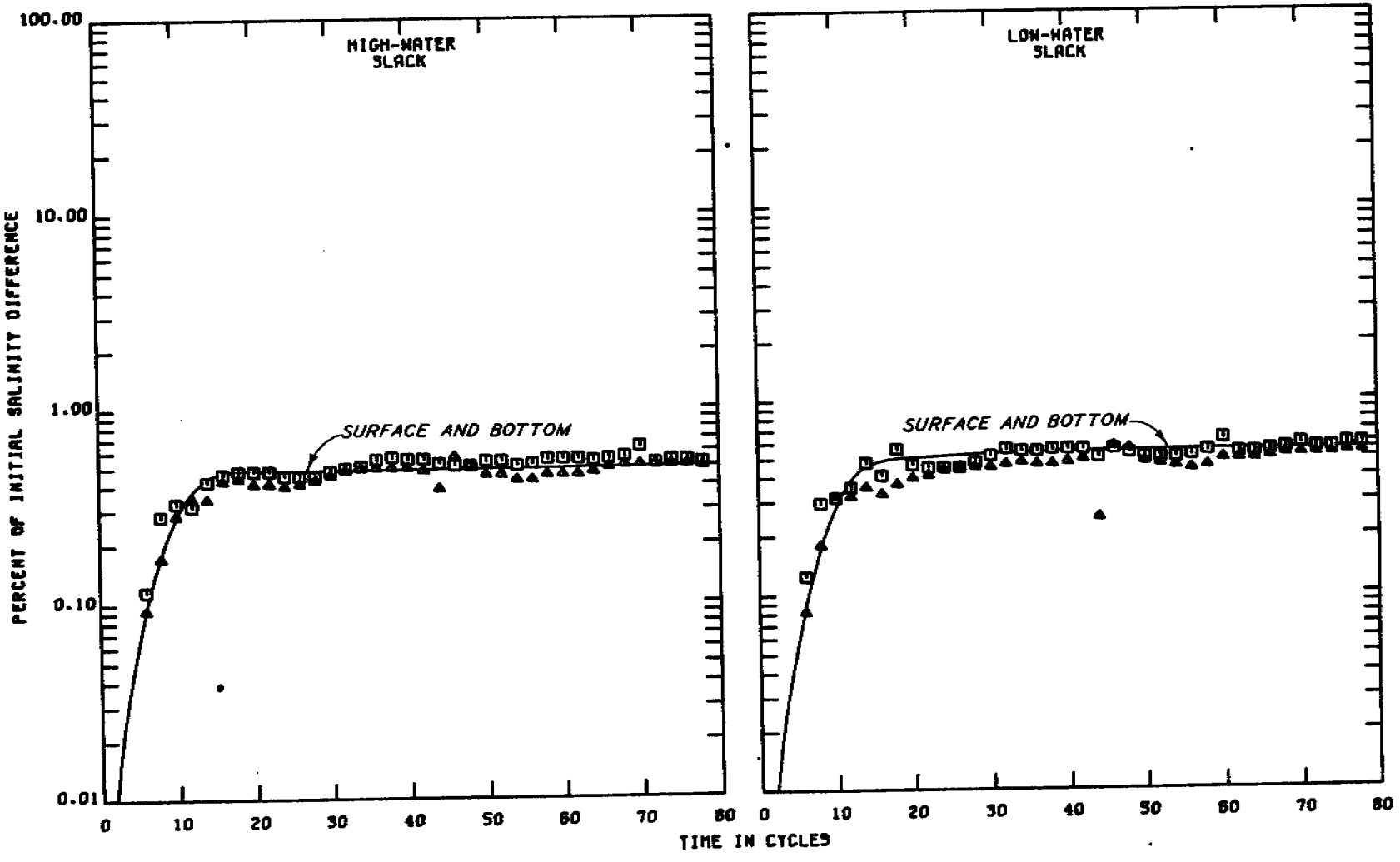
△ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION M92



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ — — — BOTTOM

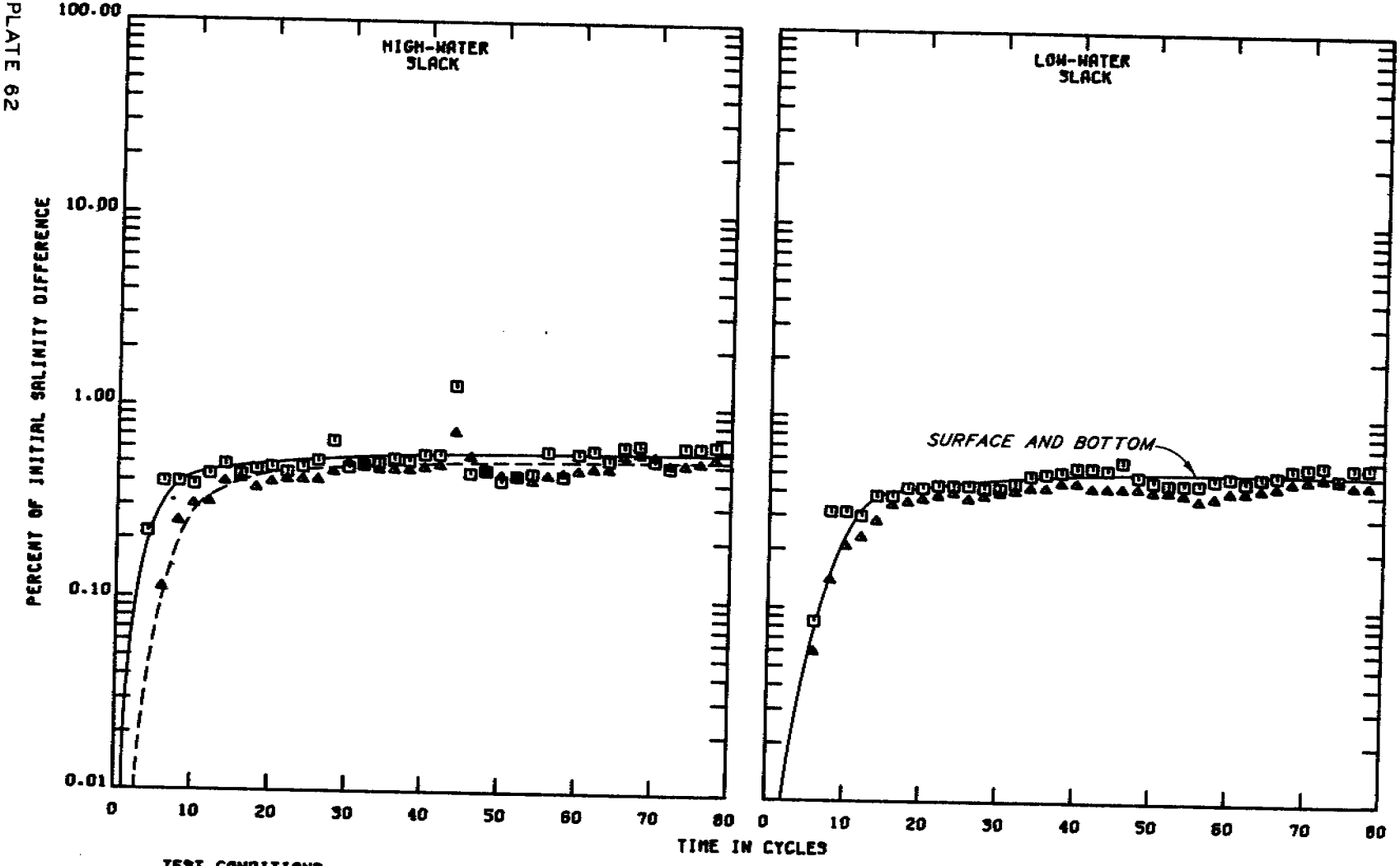
GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION LG1

PLATE 61



TEST CONDITIONS

FRESH-WATER DISCHARGE	11929 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

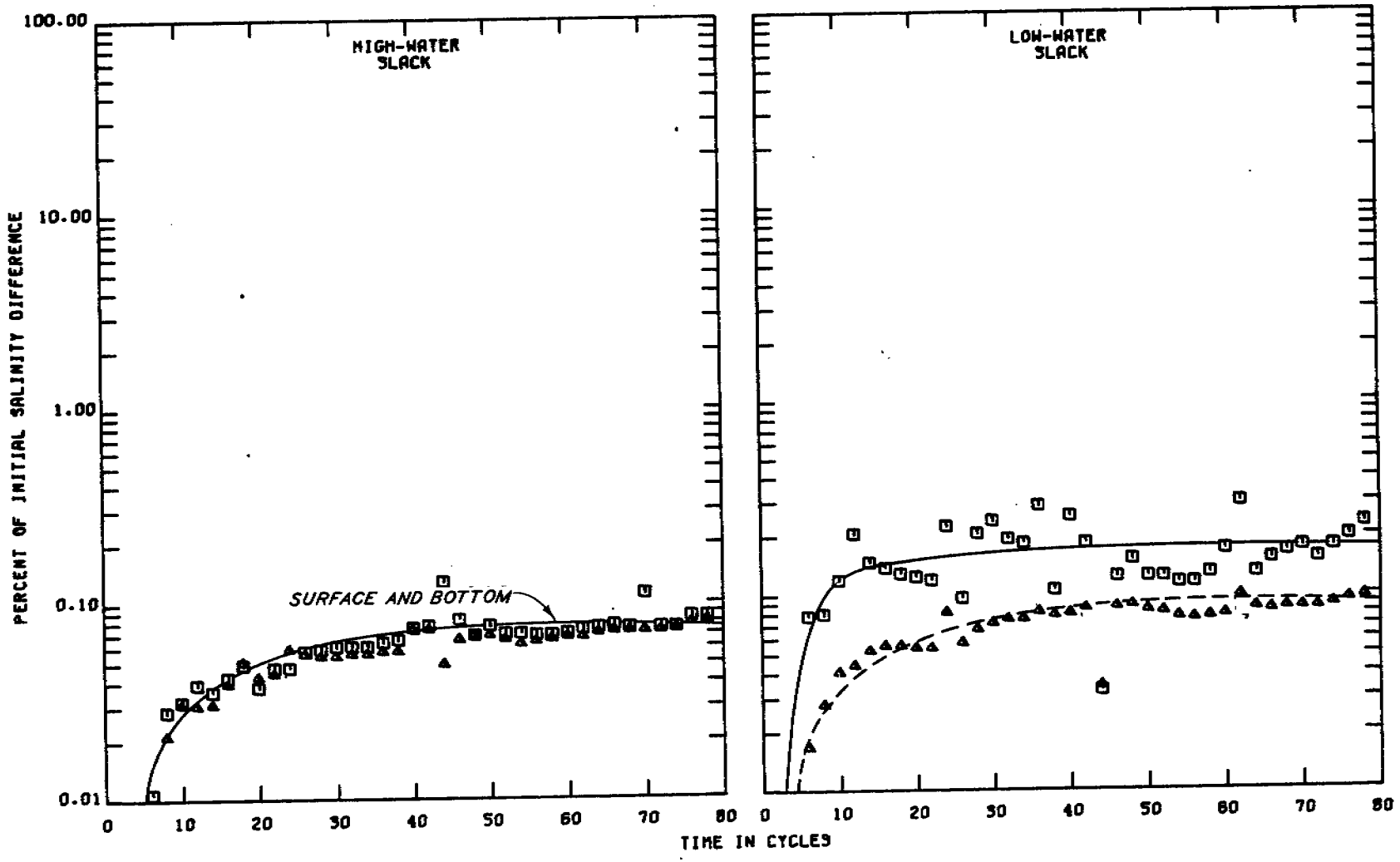
▲ - - - BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION LG2



TEST CONDITIONS

FRESH-WATER DISCHARGE	11329 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

GALVESTON BAY MODEL

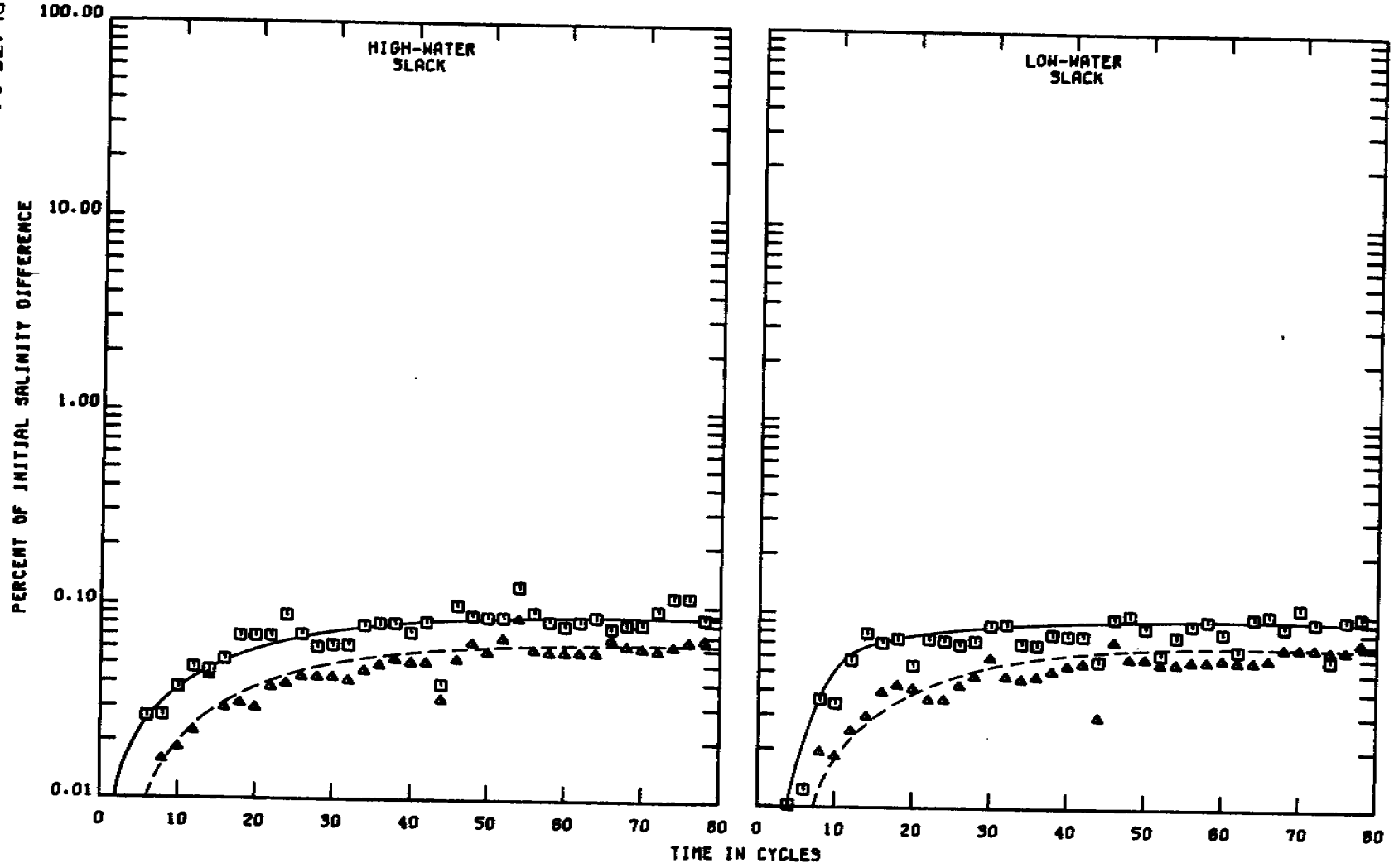
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION LG3

PLATE 63

PLATE 64



TEST CONDITIONS

FRESH-WATER DISCHARGE	11923 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

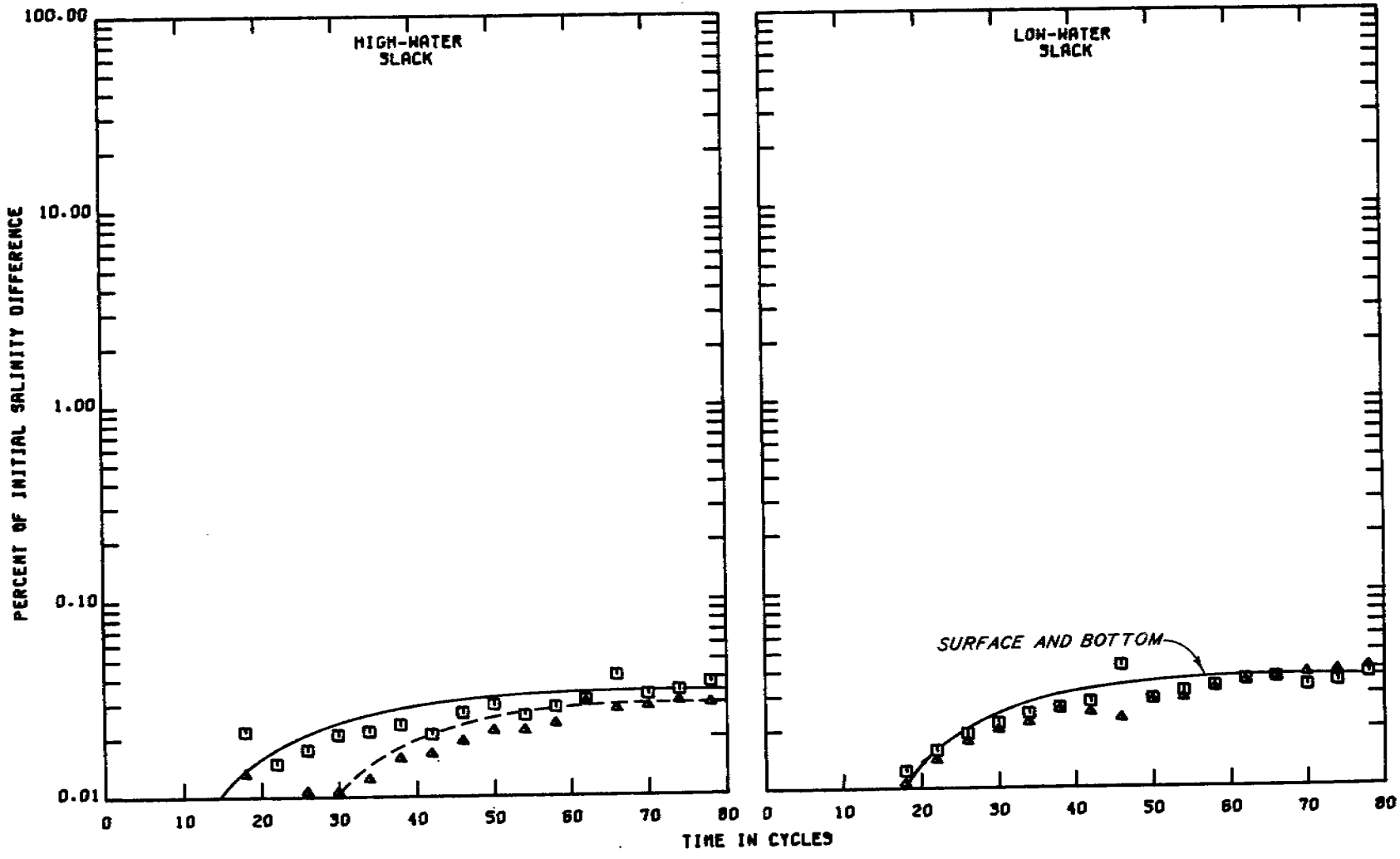
▲ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION LG4



TEST CONDITIONS

FRESH-WATER DISCHARGE	11923 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

GALVESTON BAY MODEL

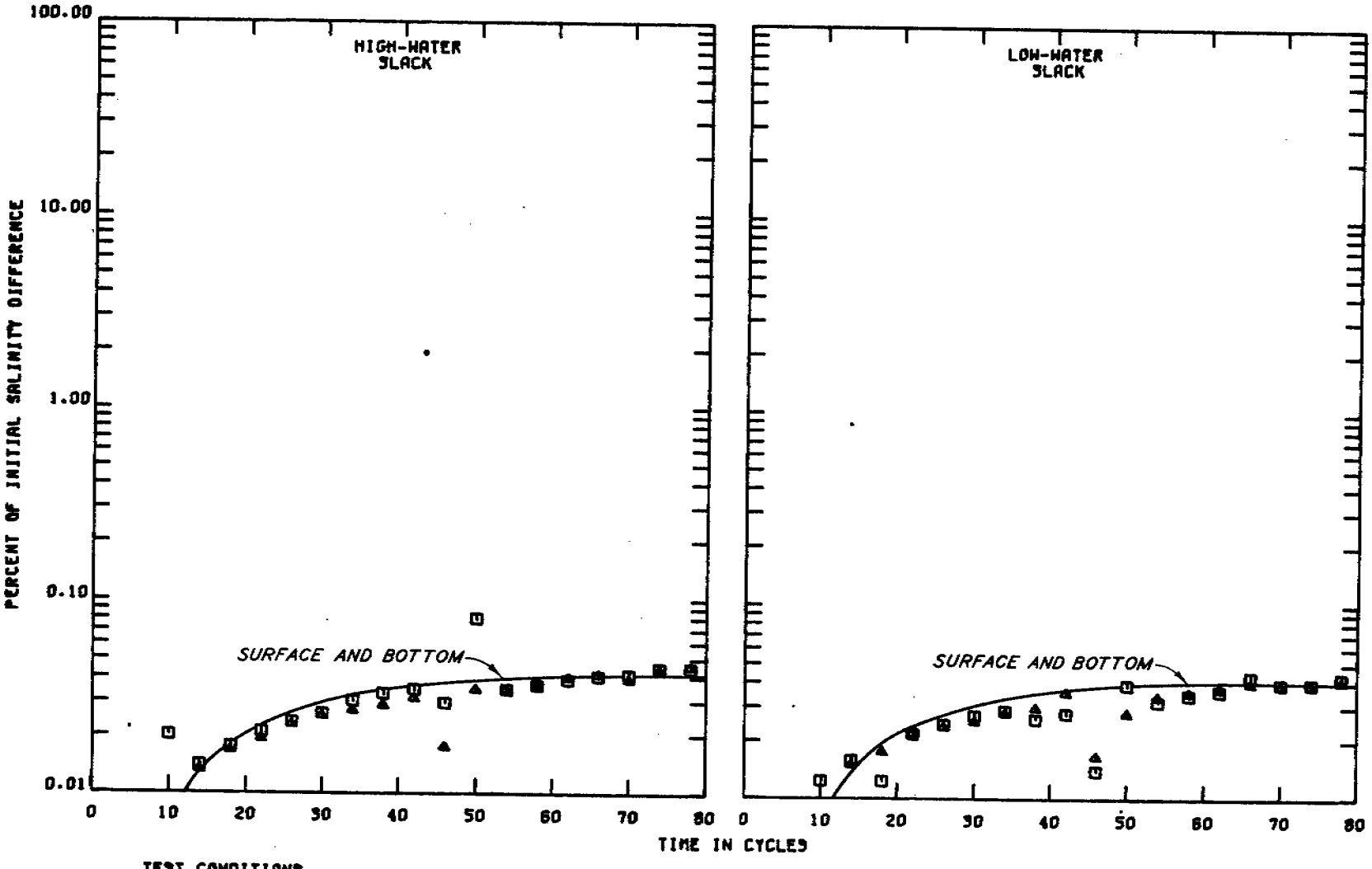
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION LG5

PLATE 65

PLATE 66



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

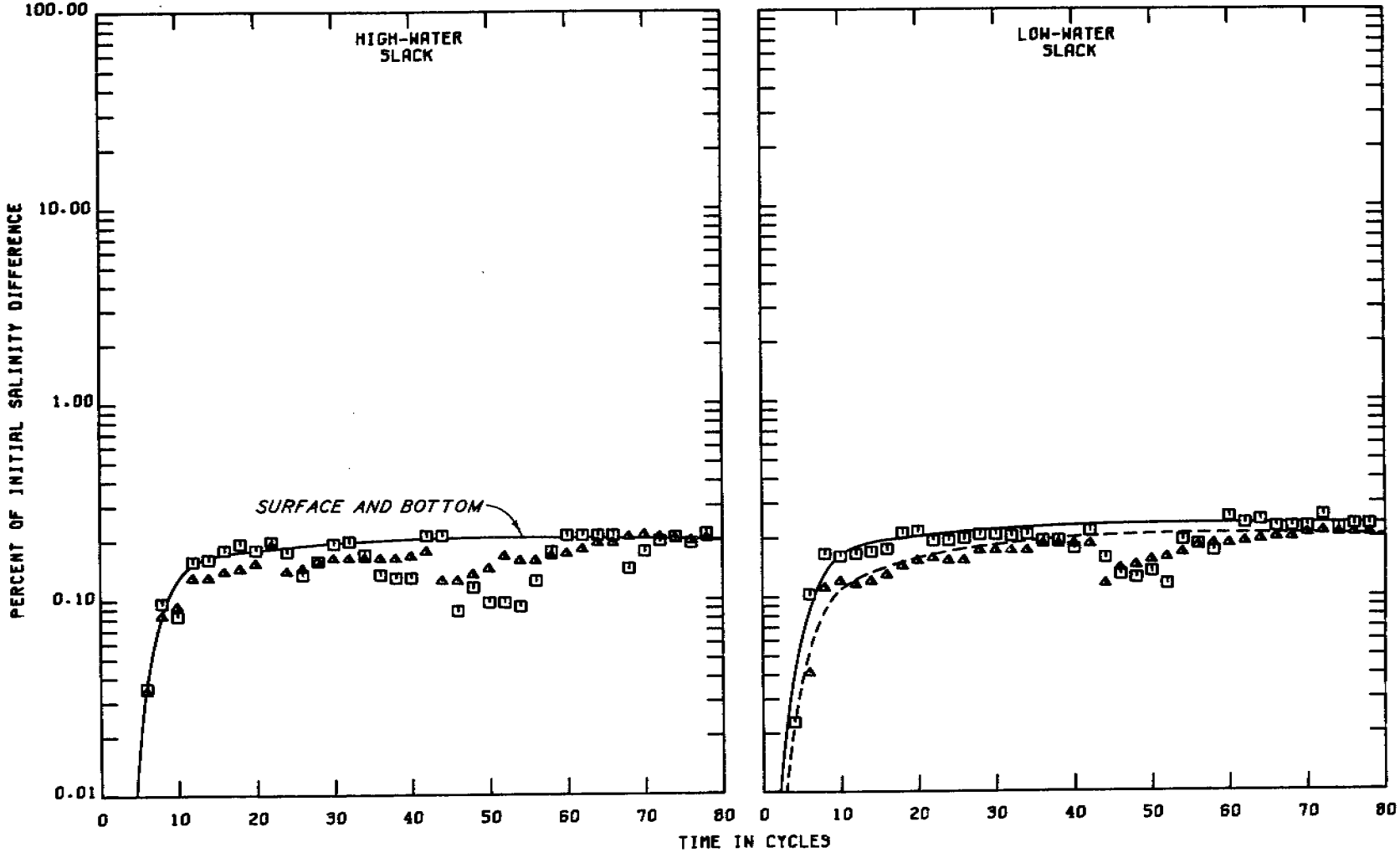
△ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION LG8



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

GALVESTON BAY MODEL

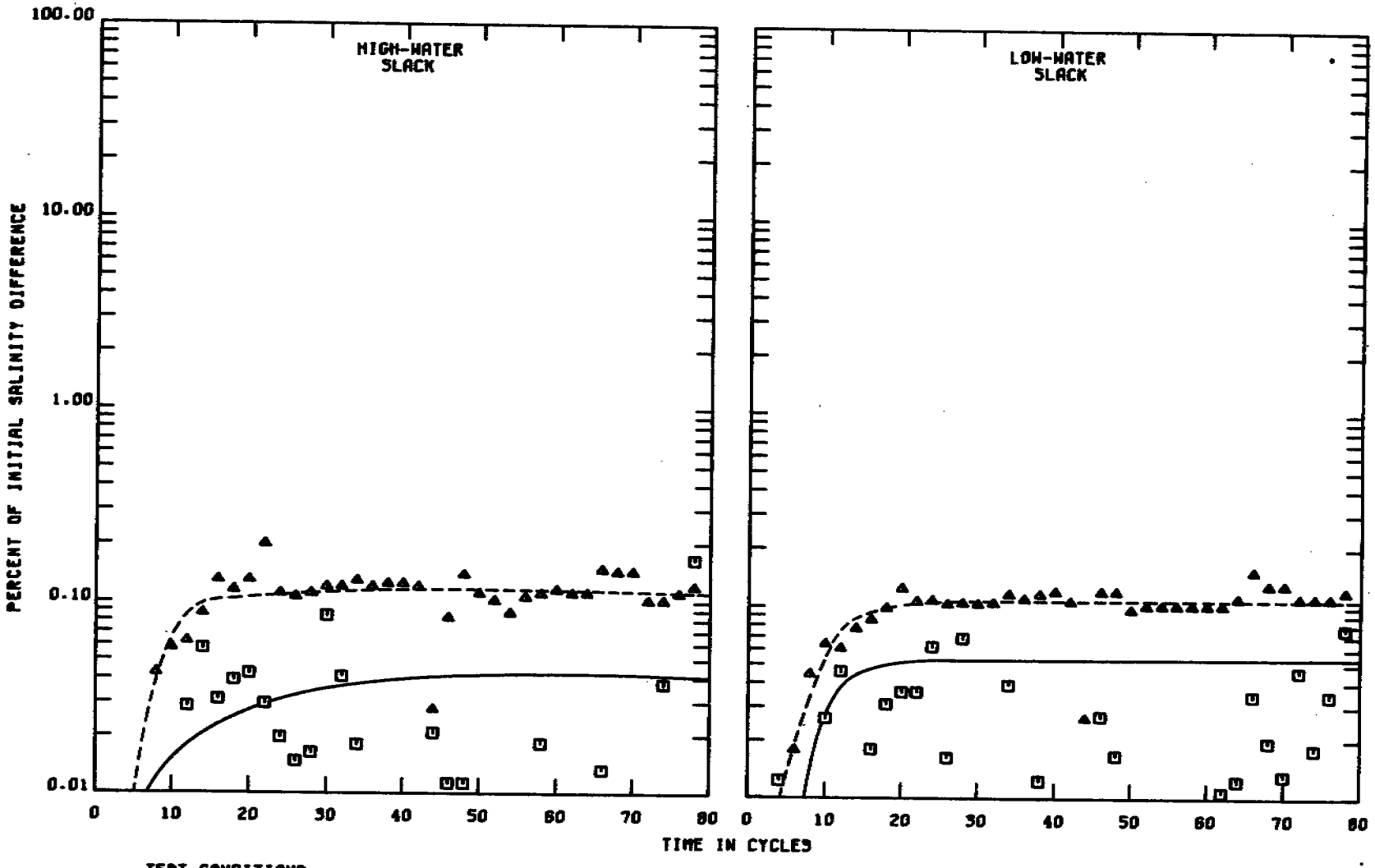
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION DB

PLATE 67

PLATE 68



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION RIC

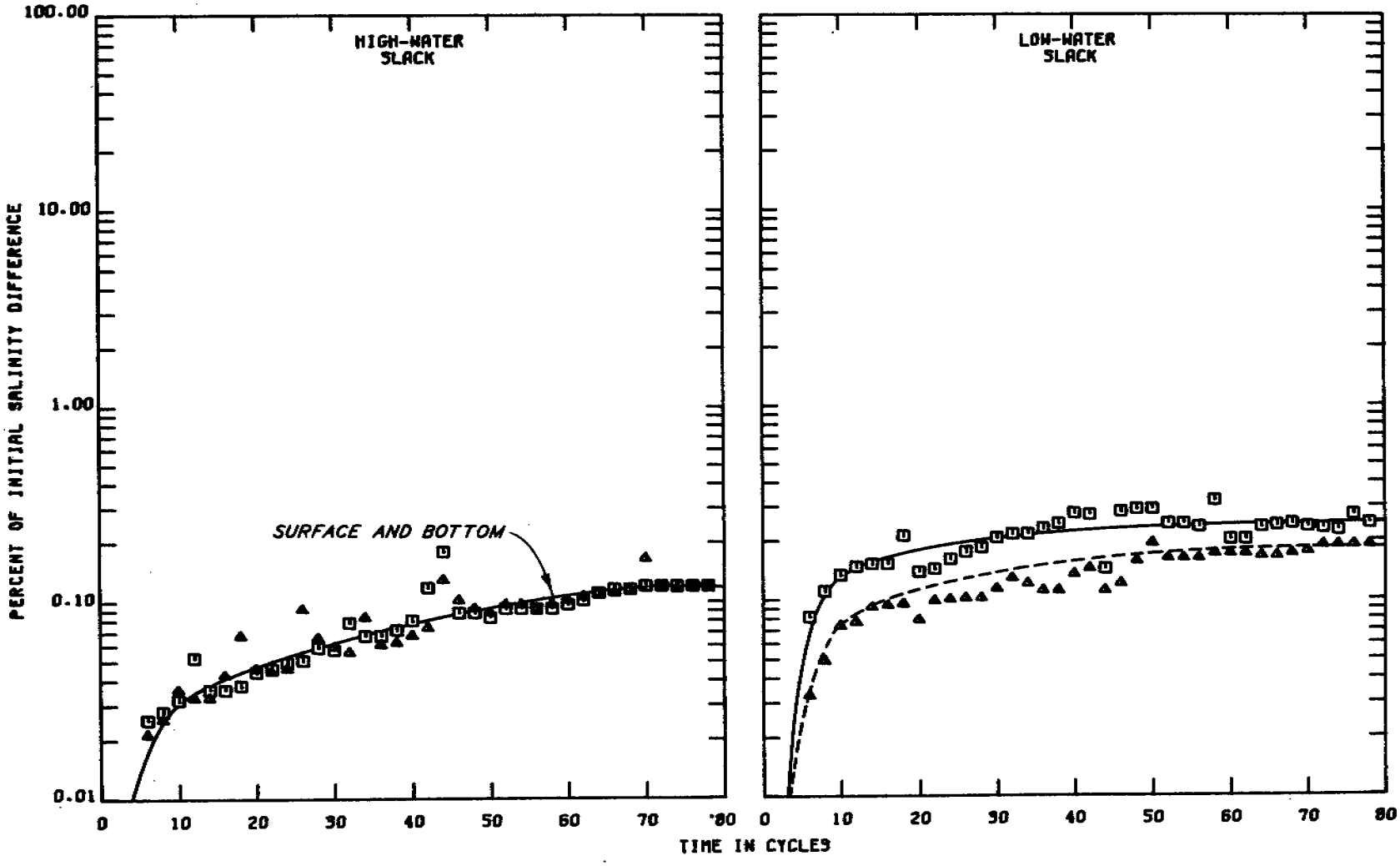


PLATE 69

TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ — — — BOTTOM

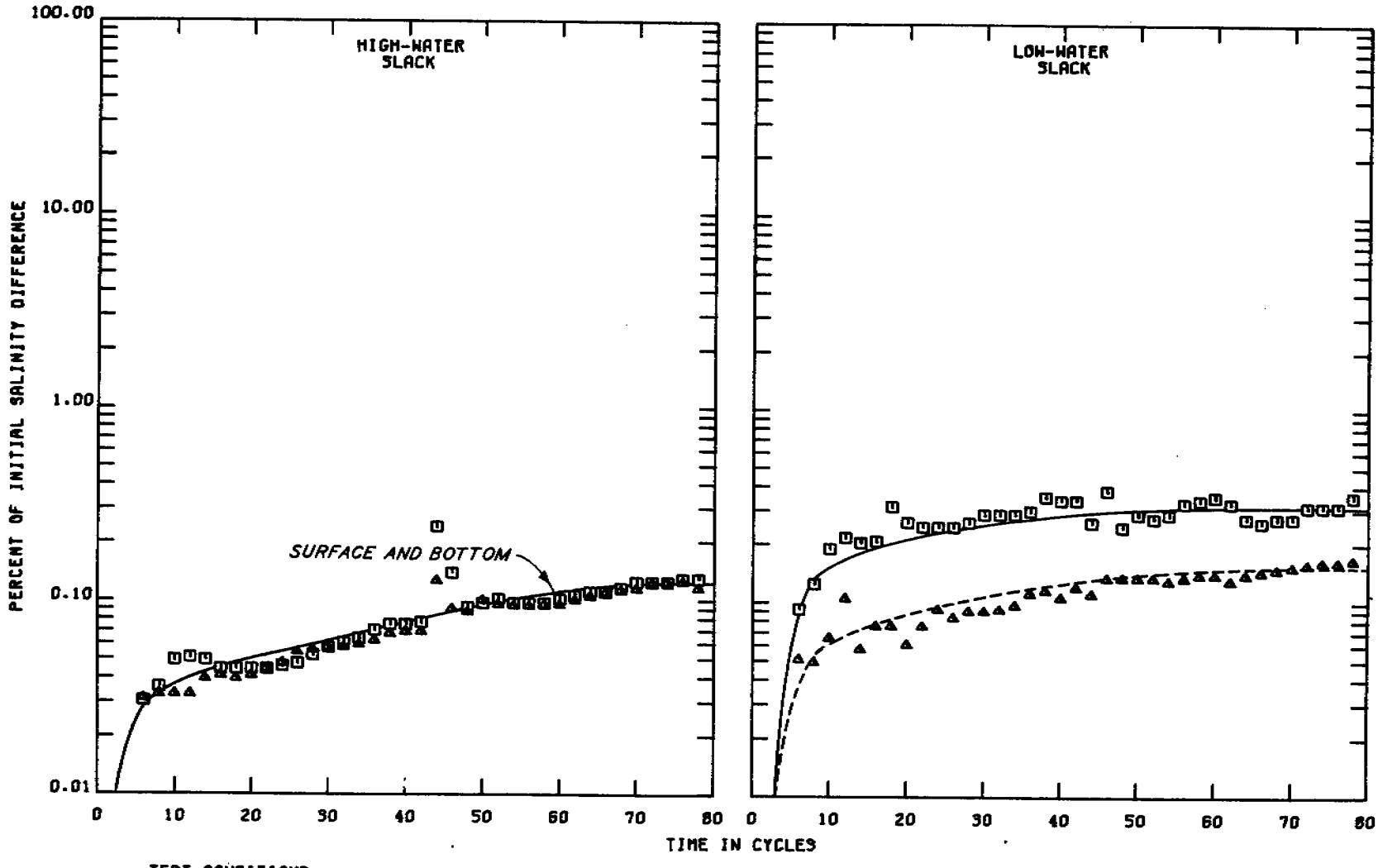
GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C1

PLATE 70



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

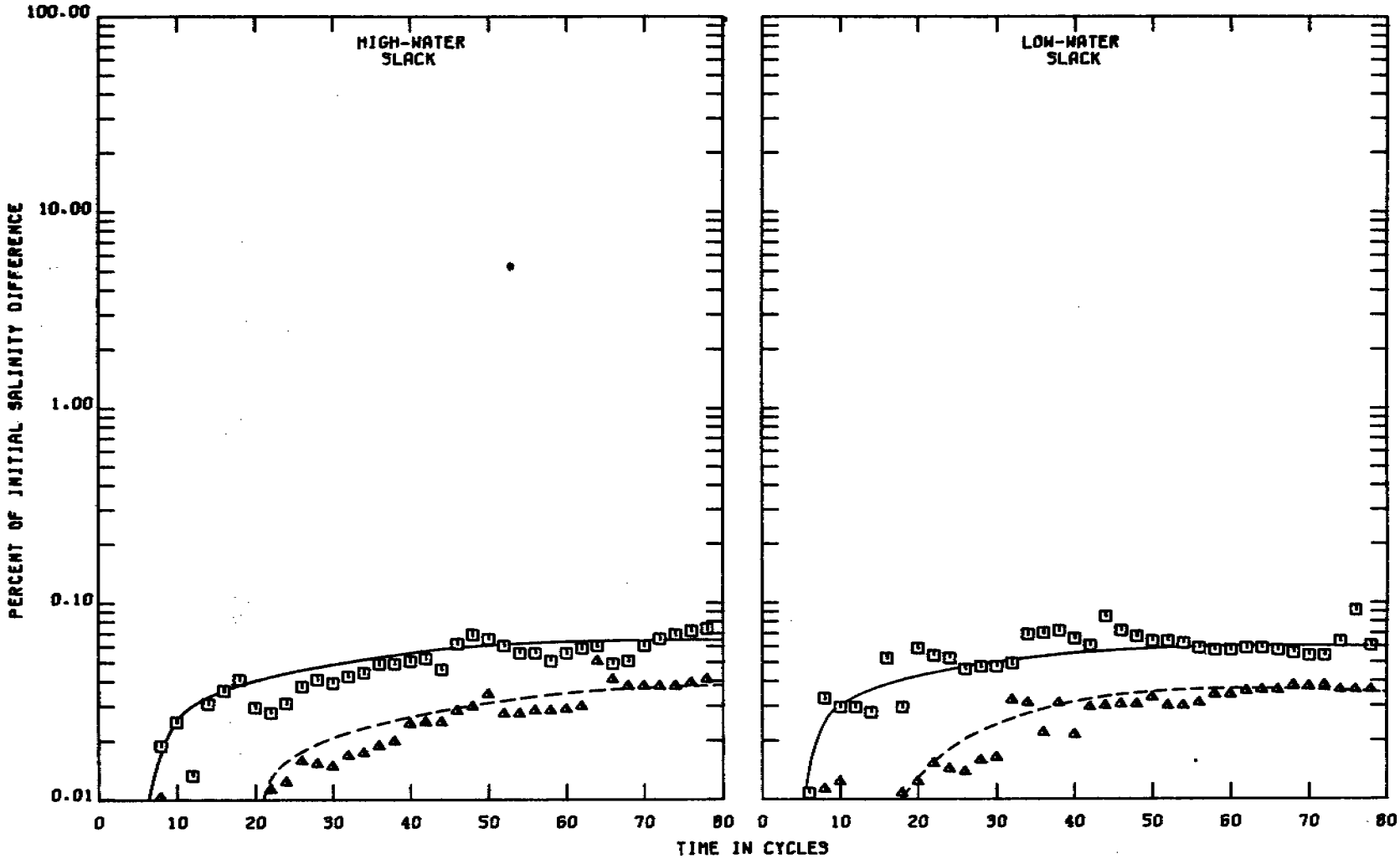
△ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C2



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

BOTTOM

GALVESTON BAY MODEL

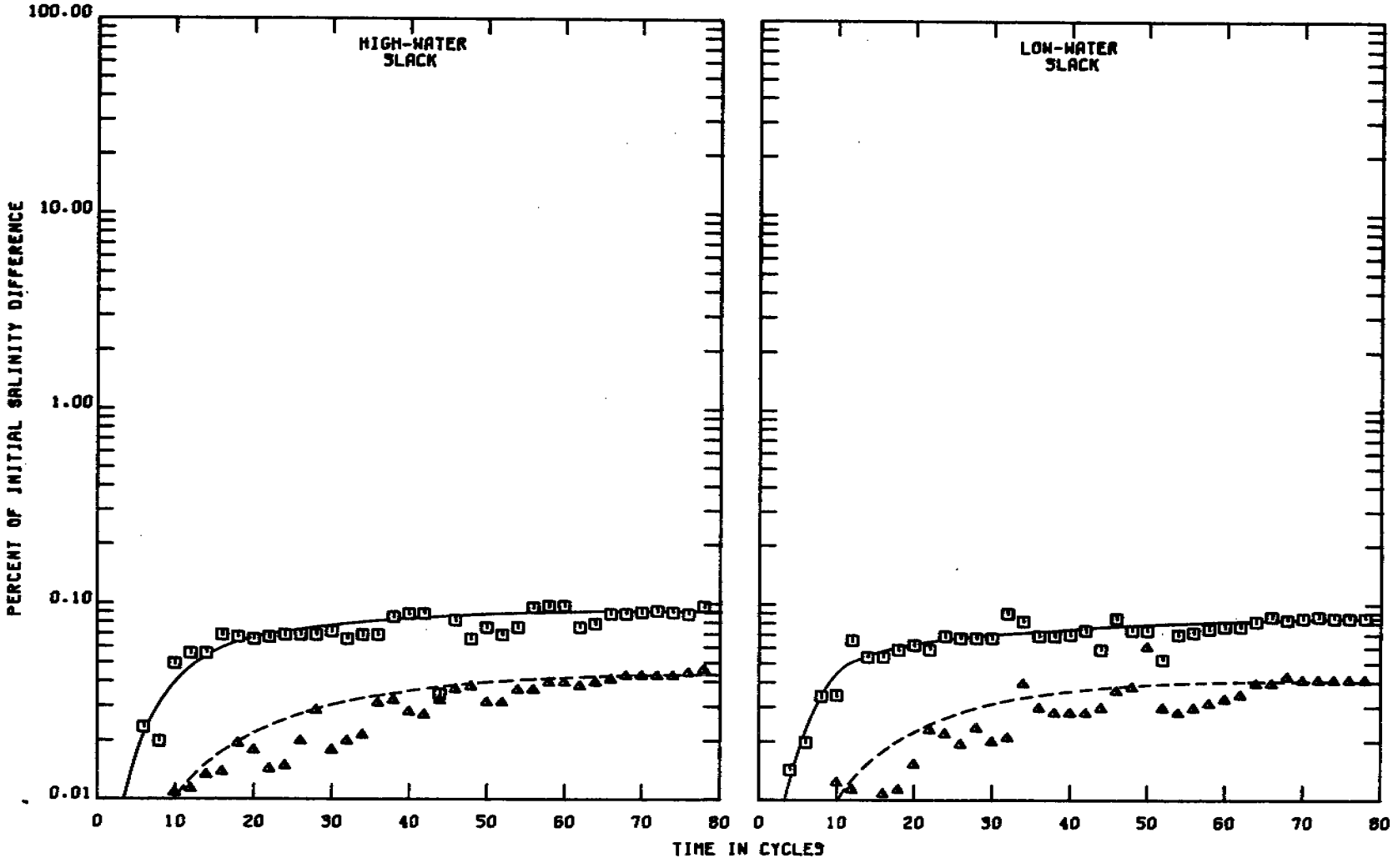
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C3

PLATE 71

PLATE 72



TEST CONDITIONS

FRESH-WATER DISCHARGE	11329 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

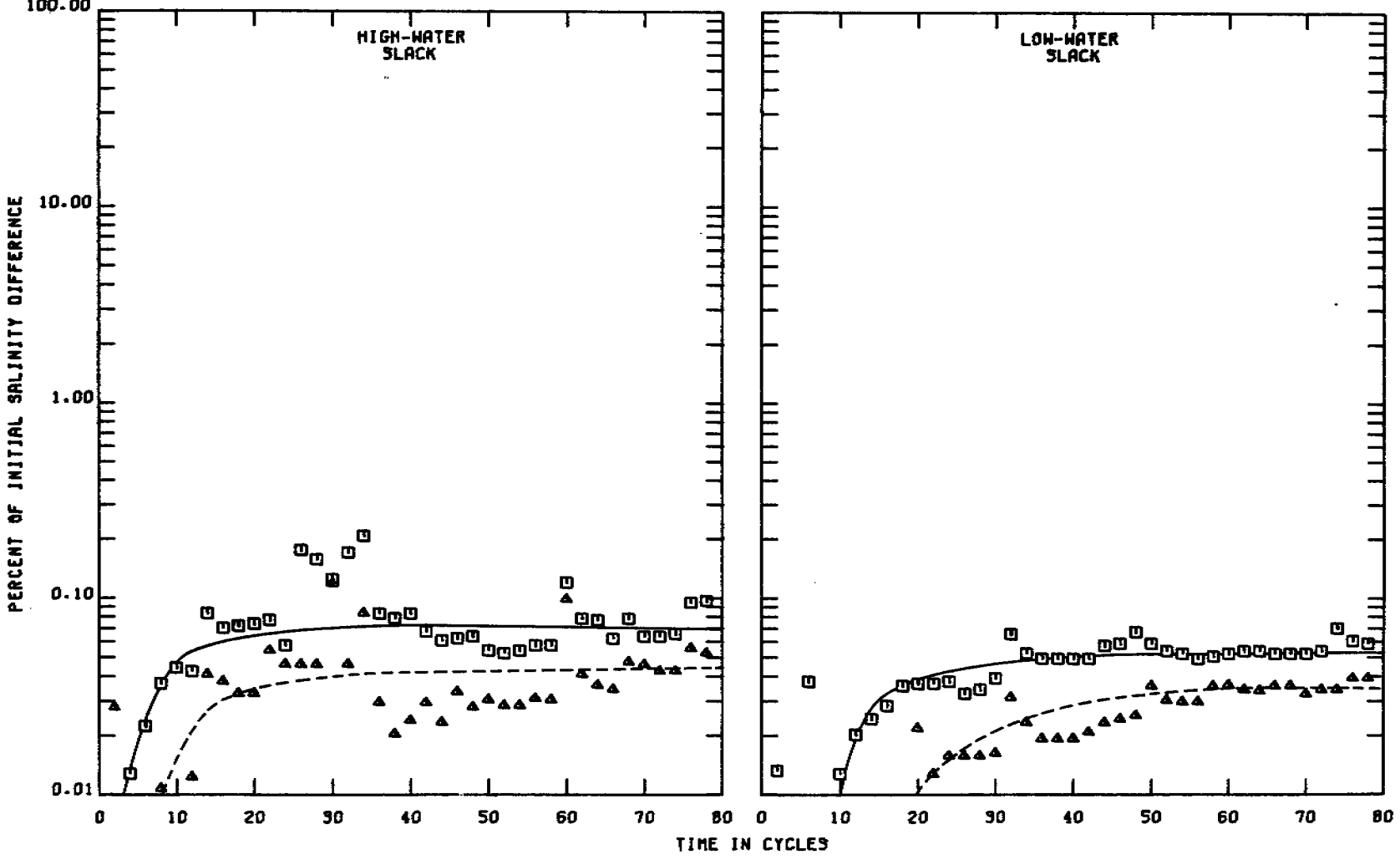
△ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C4



TEST CONDITIONS

FRESH-WATER DISCHARGE	11329 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

GALVESTON BAY MODEL

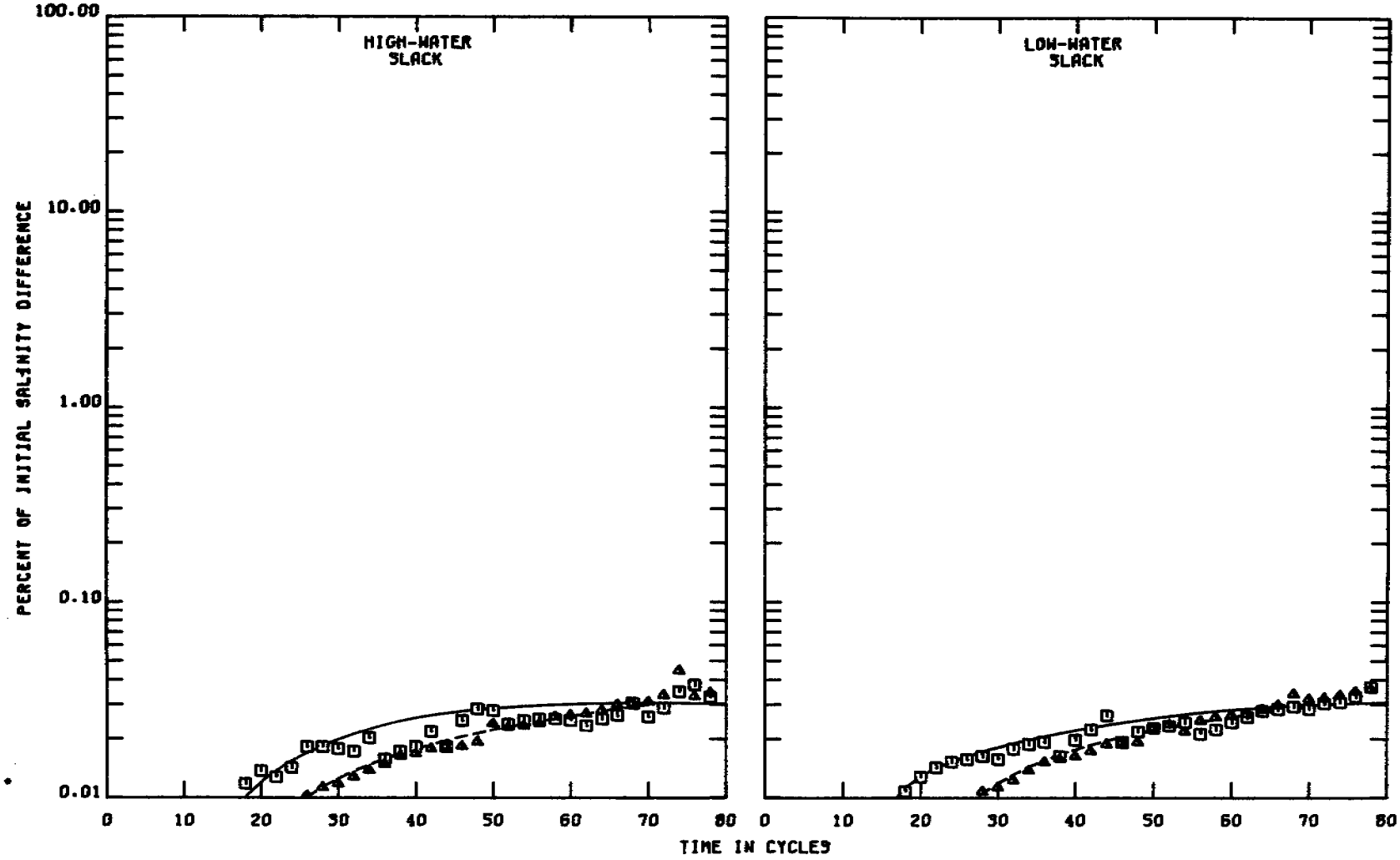
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C5

PLATE 73

PLATE 74



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

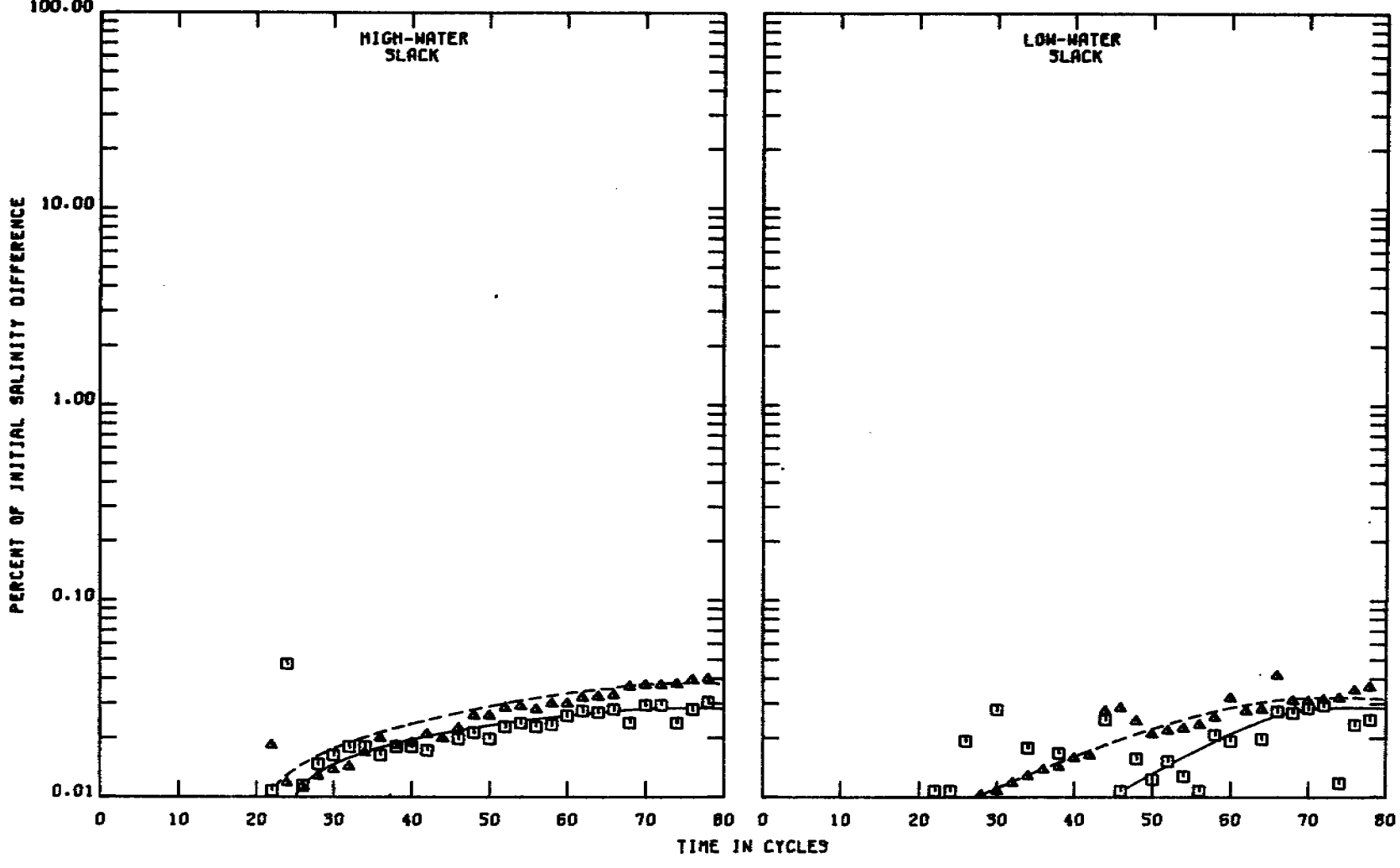
△ - - - BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C6



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

GALVESTON BAY MODEL

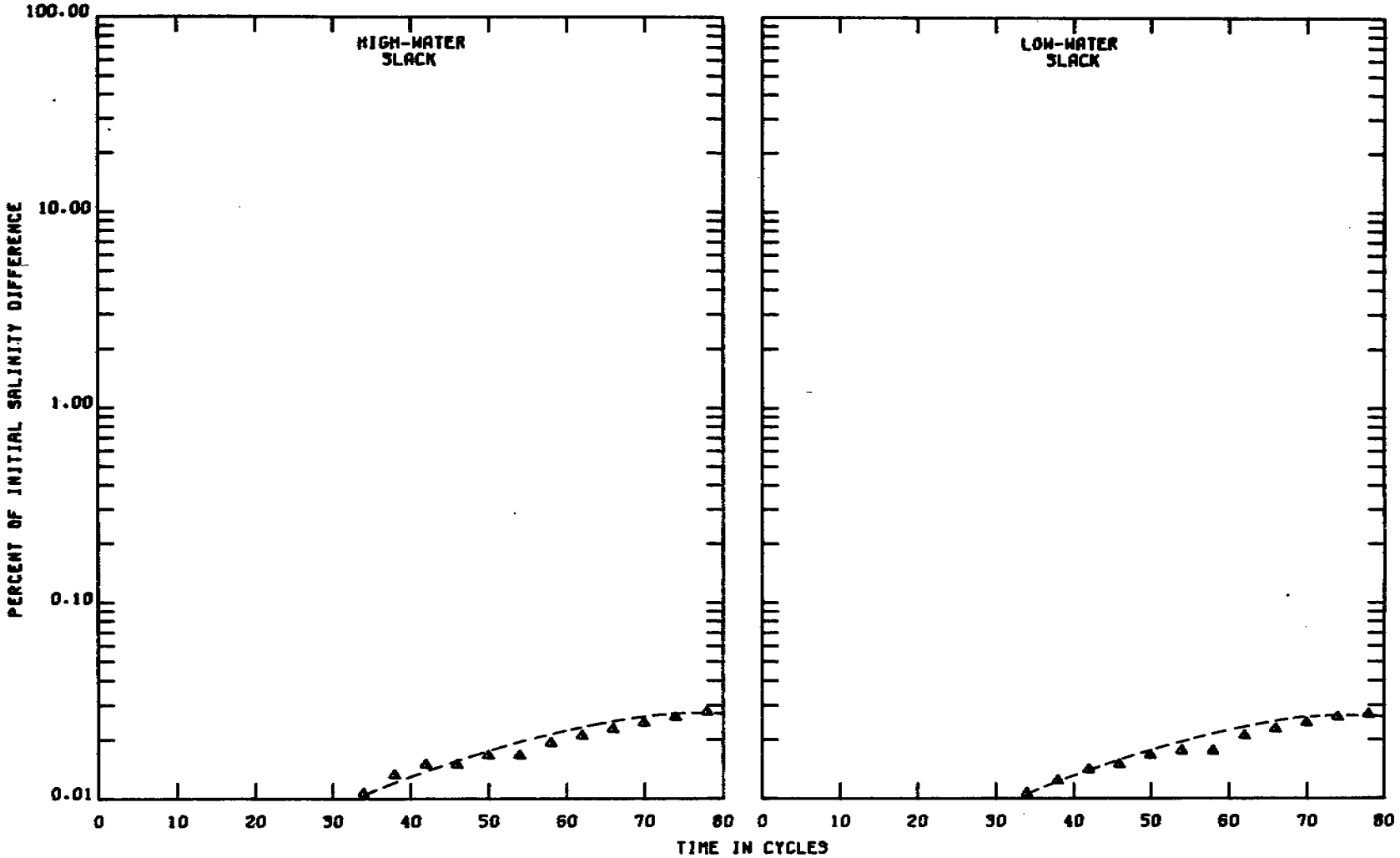
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C7

PLATE 75

PLATE 76



TEST CONDITIONS

FRESH-WATER DISCHARGE	11929 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

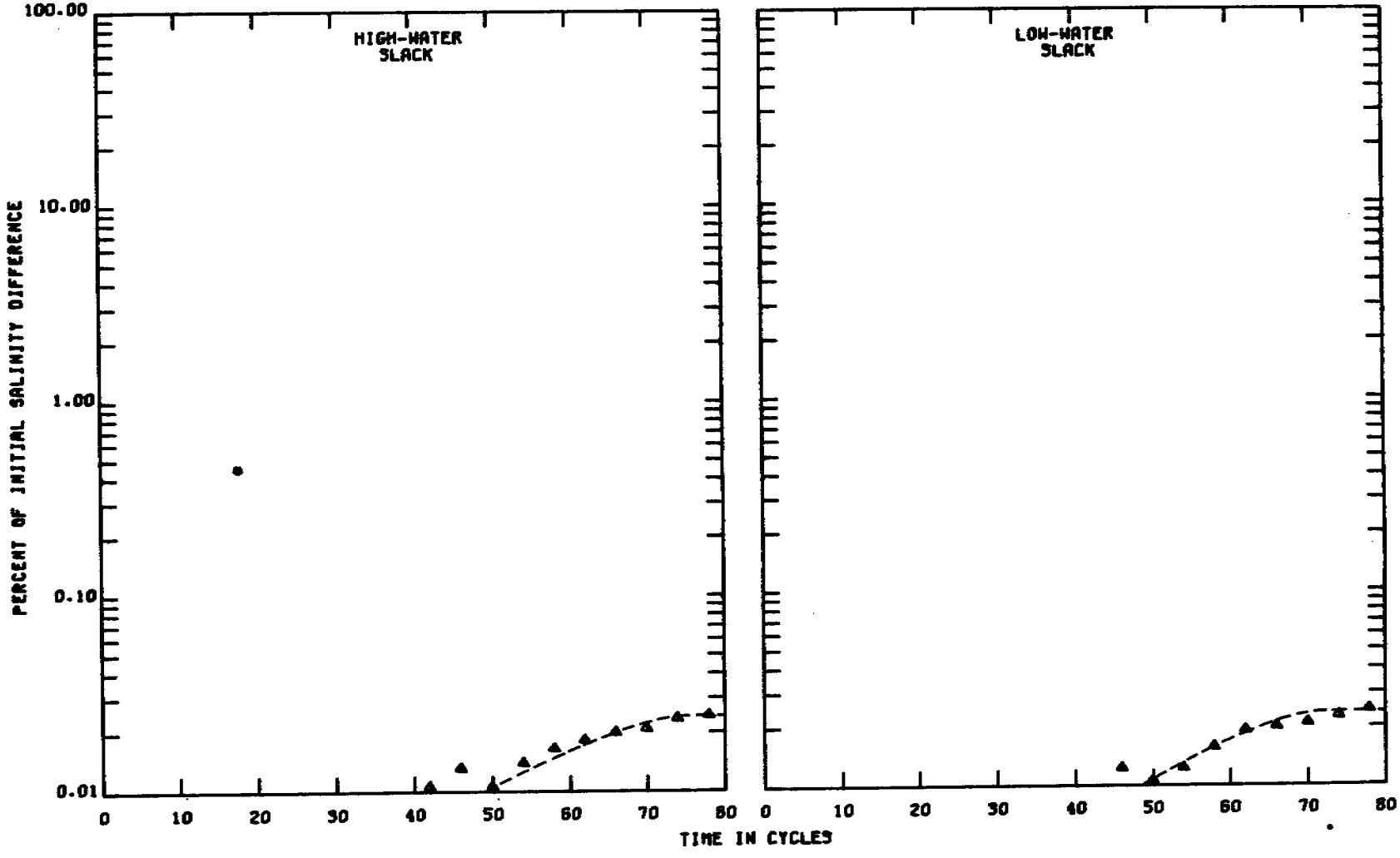
▲ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C8



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

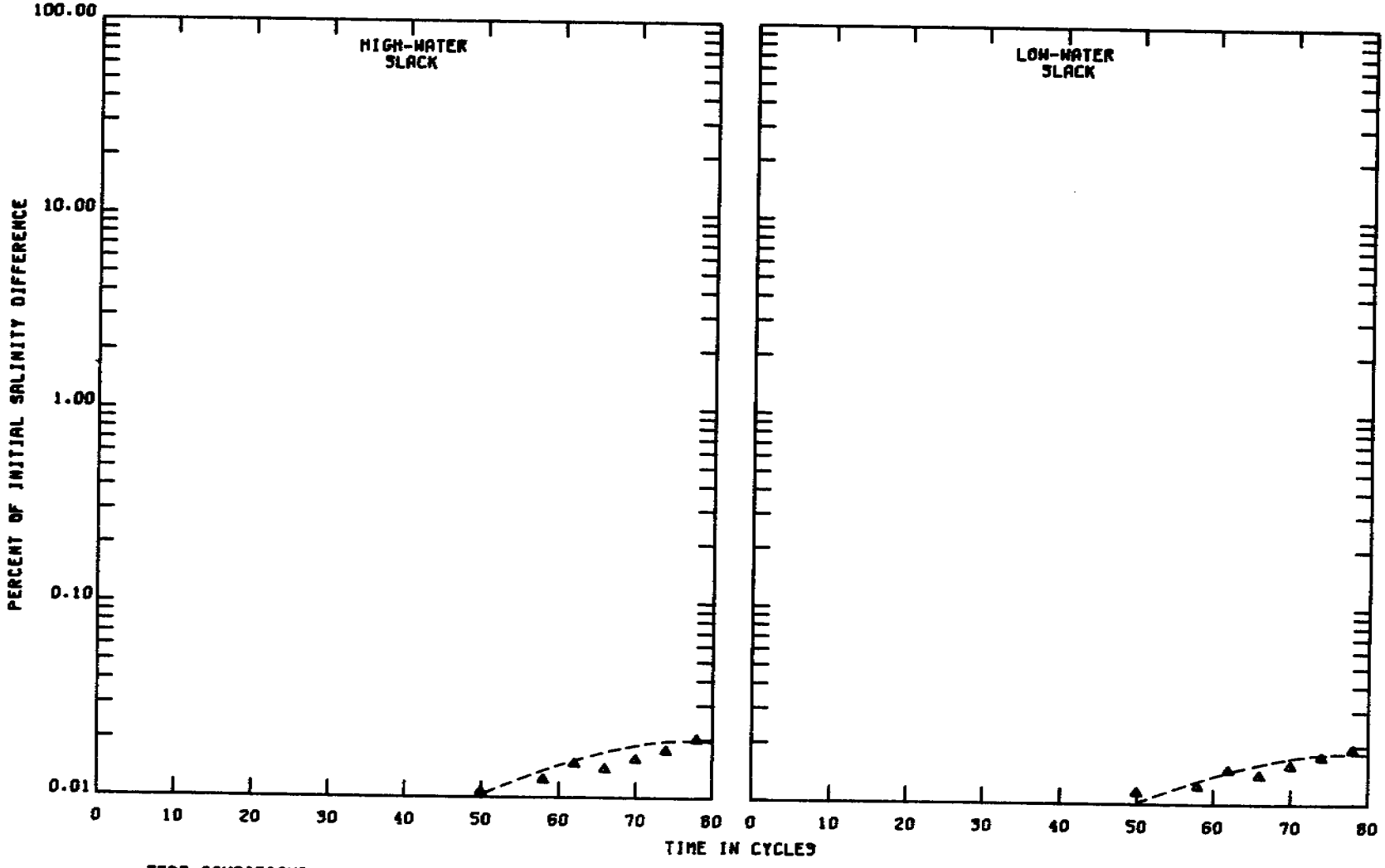
GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C9

PLATE 77



TEST CONDITIONS

FRESH-WATER DISCHARGE	11929 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

⊡ —— SURFACE

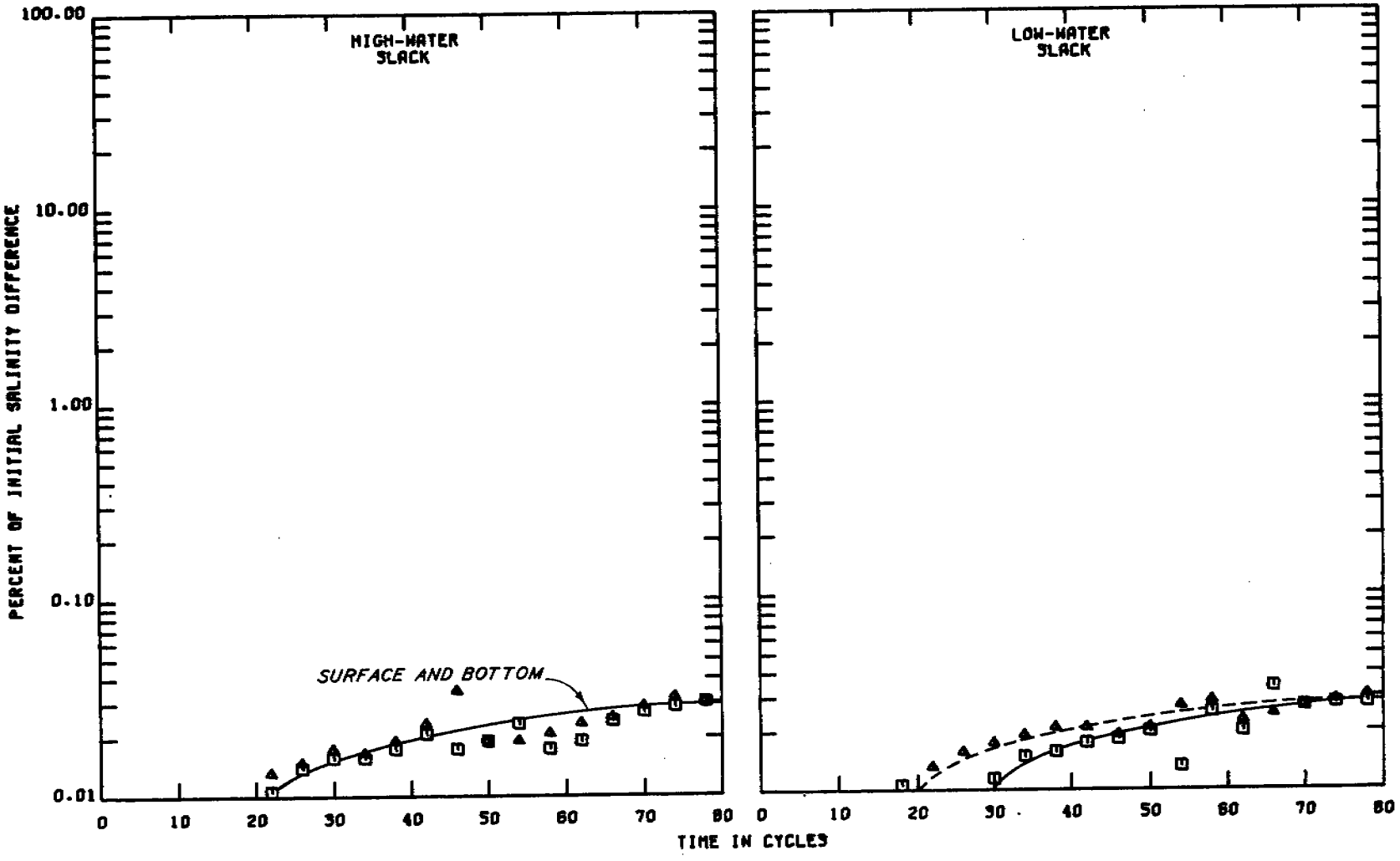
▲ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION C10



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

GALVESTON BAY MODEL

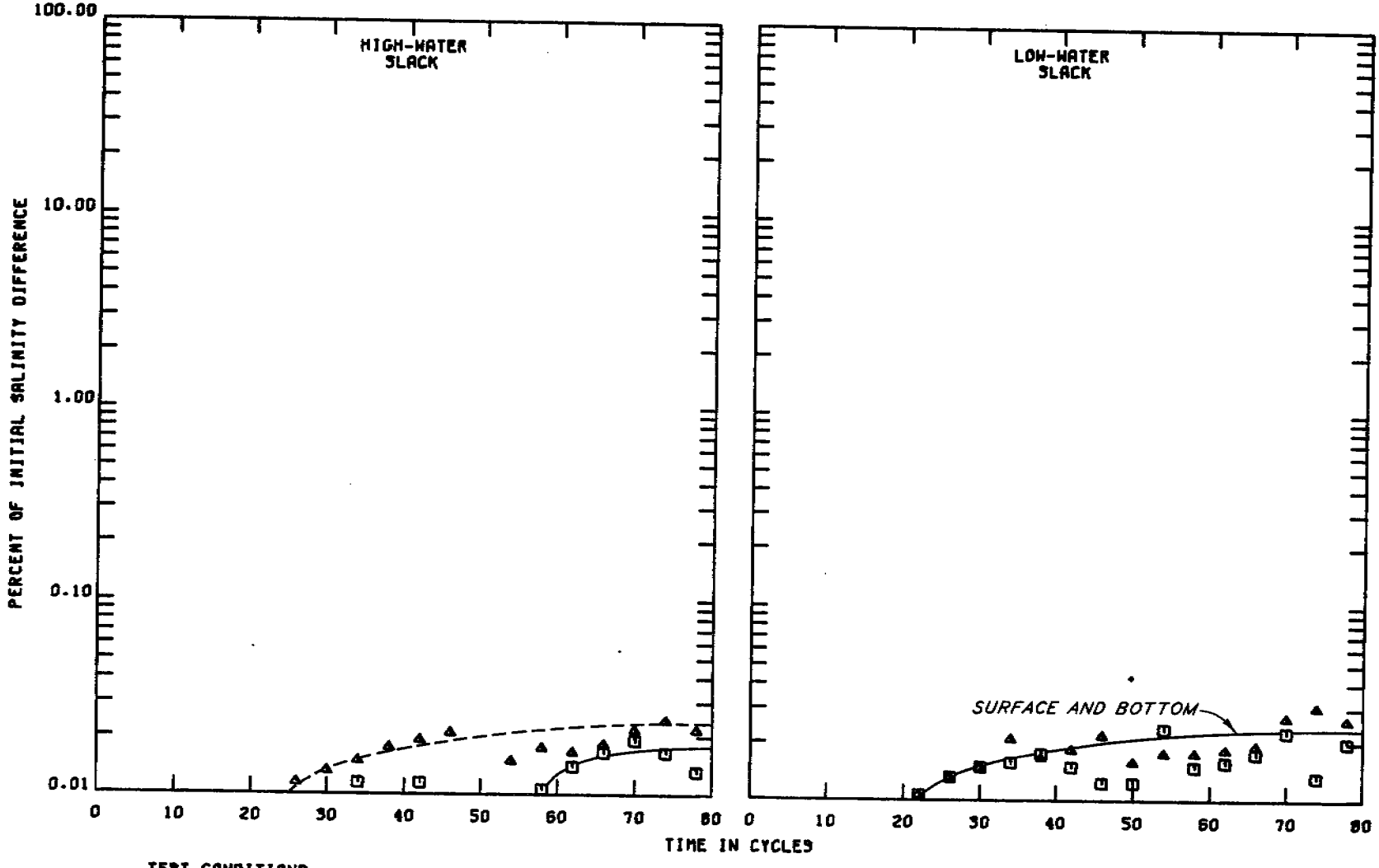
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION T82

PLATE 79

PLATE 80



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

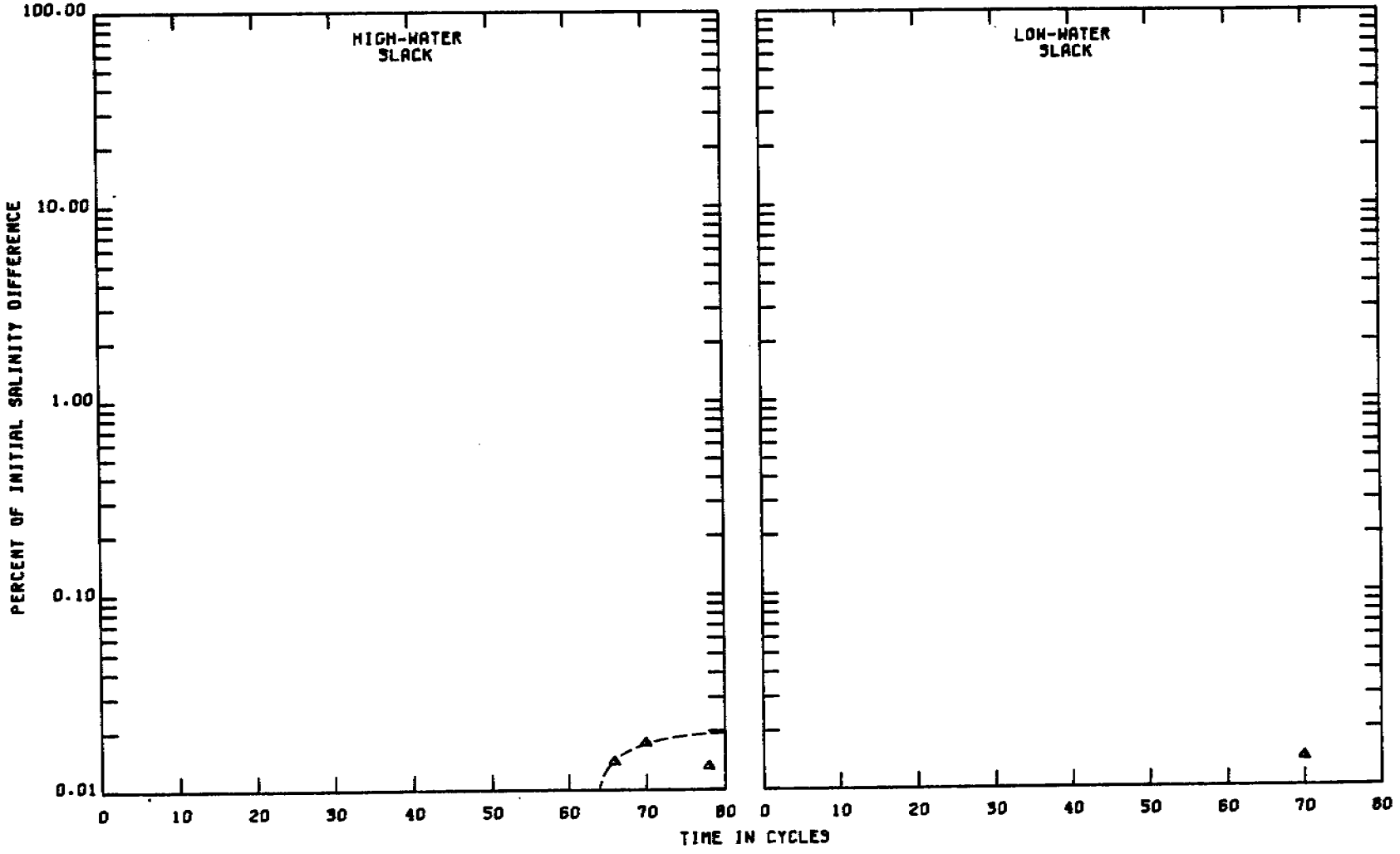
△ — — — BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION TB3



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

⊡ ——— SURFACE

▲ – – – BOTTOM

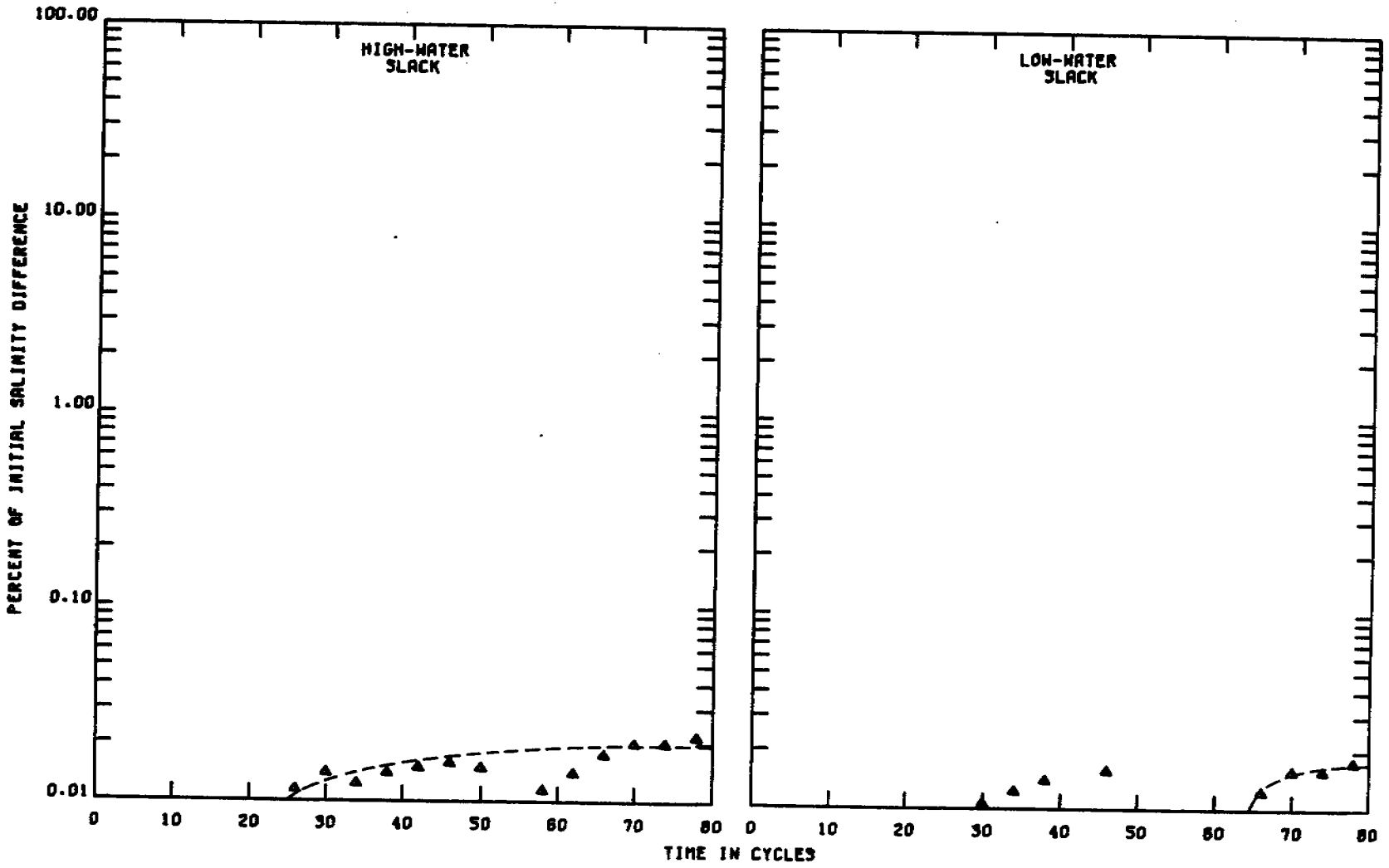
GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION T84

PLATE 81



TEST CONDITIONS

FRESH-WATER DISCHARGE	11329 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

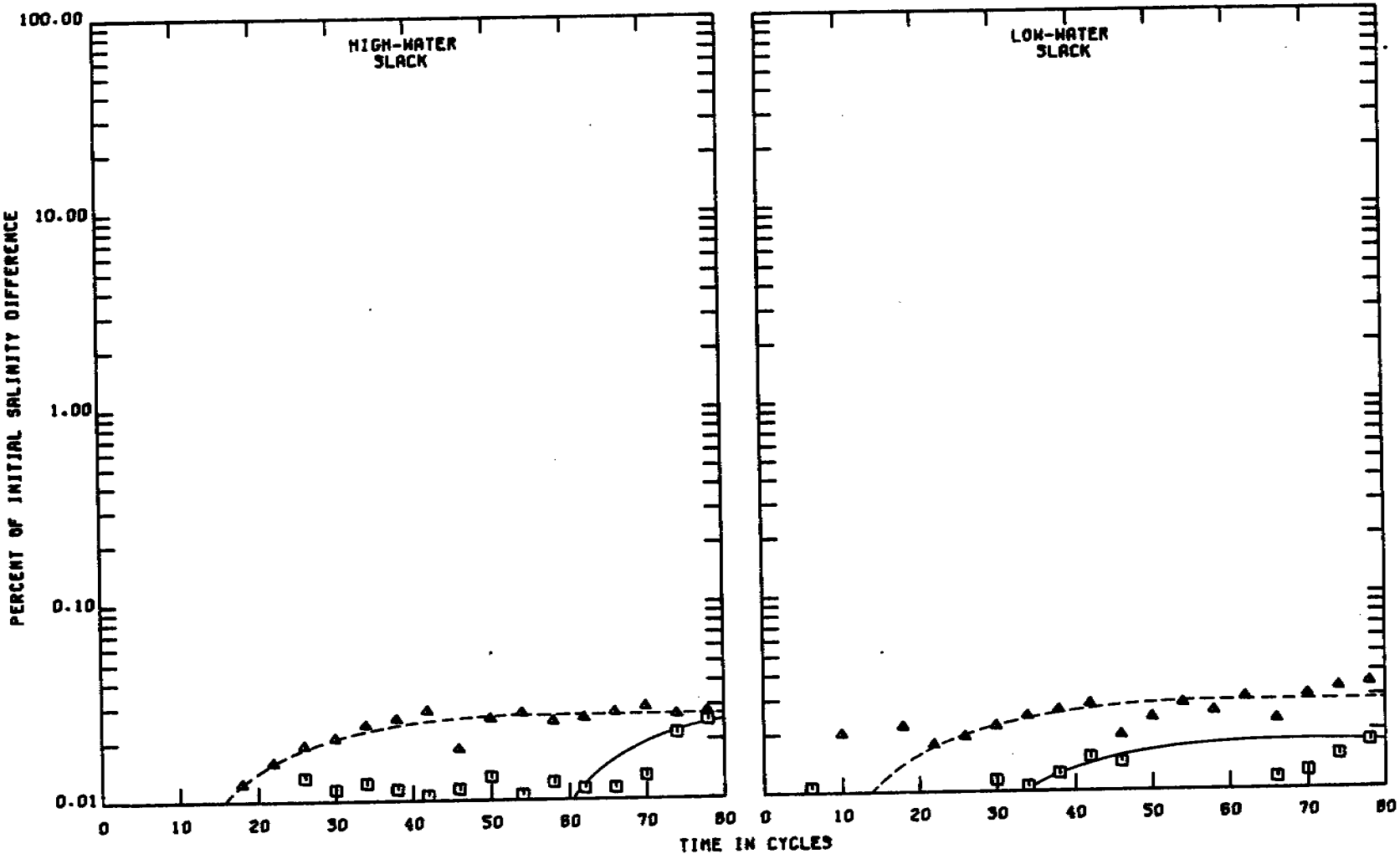
BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION T85



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

GALVESTON BAY MODEL

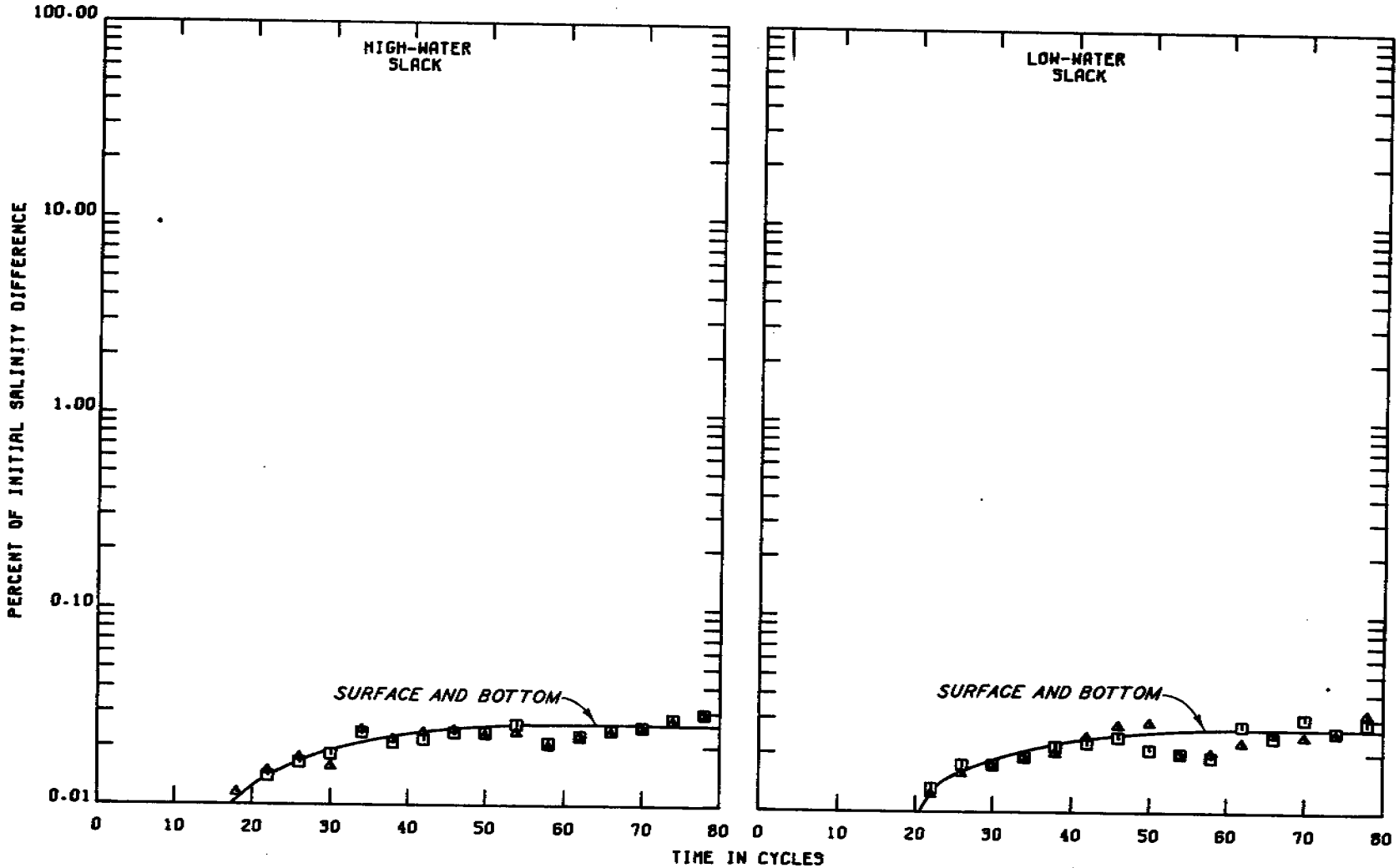
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION T86

PLATE 83

PLATE 84



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

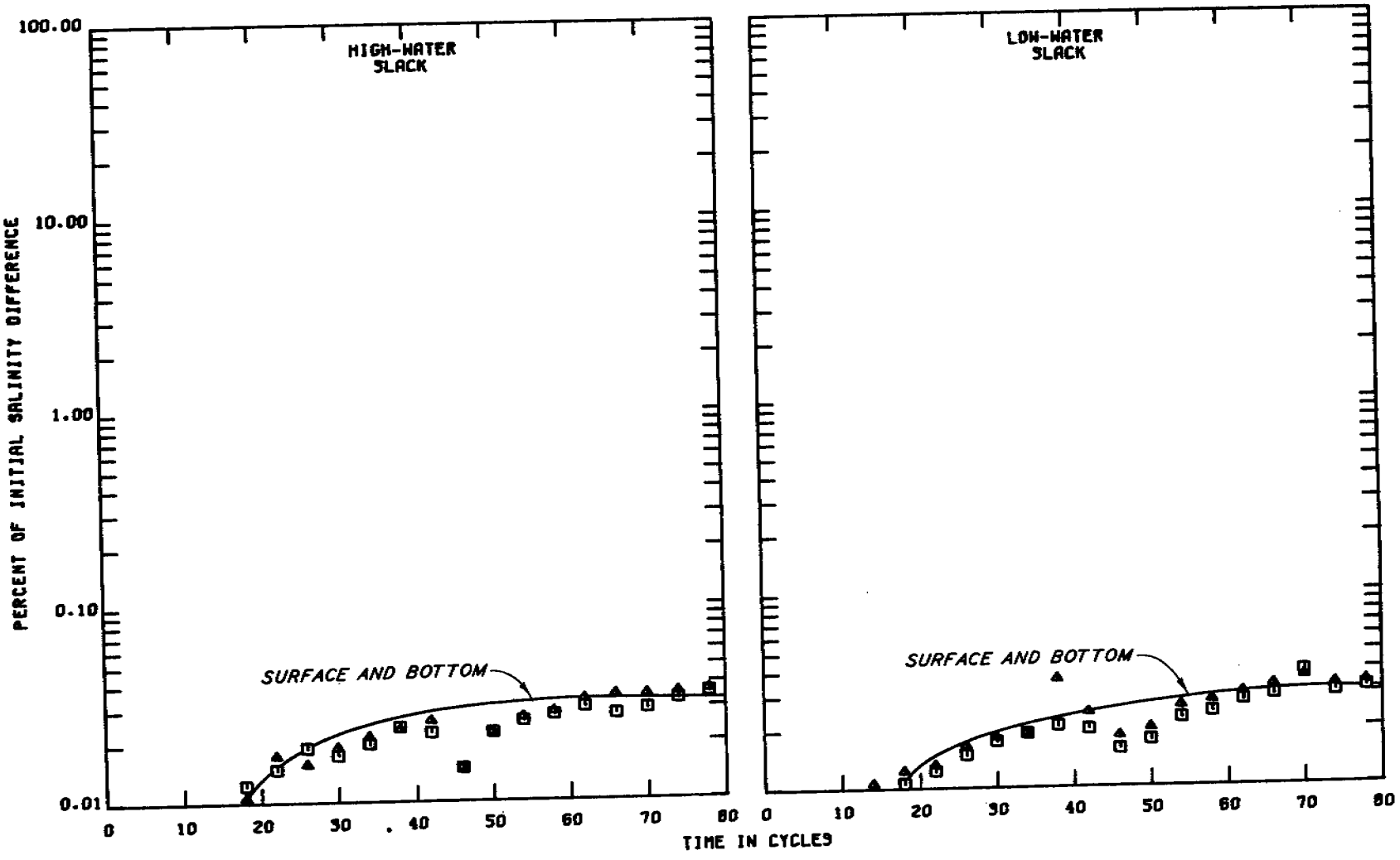
△ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION M93



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

GALVESTON BAY MODEL

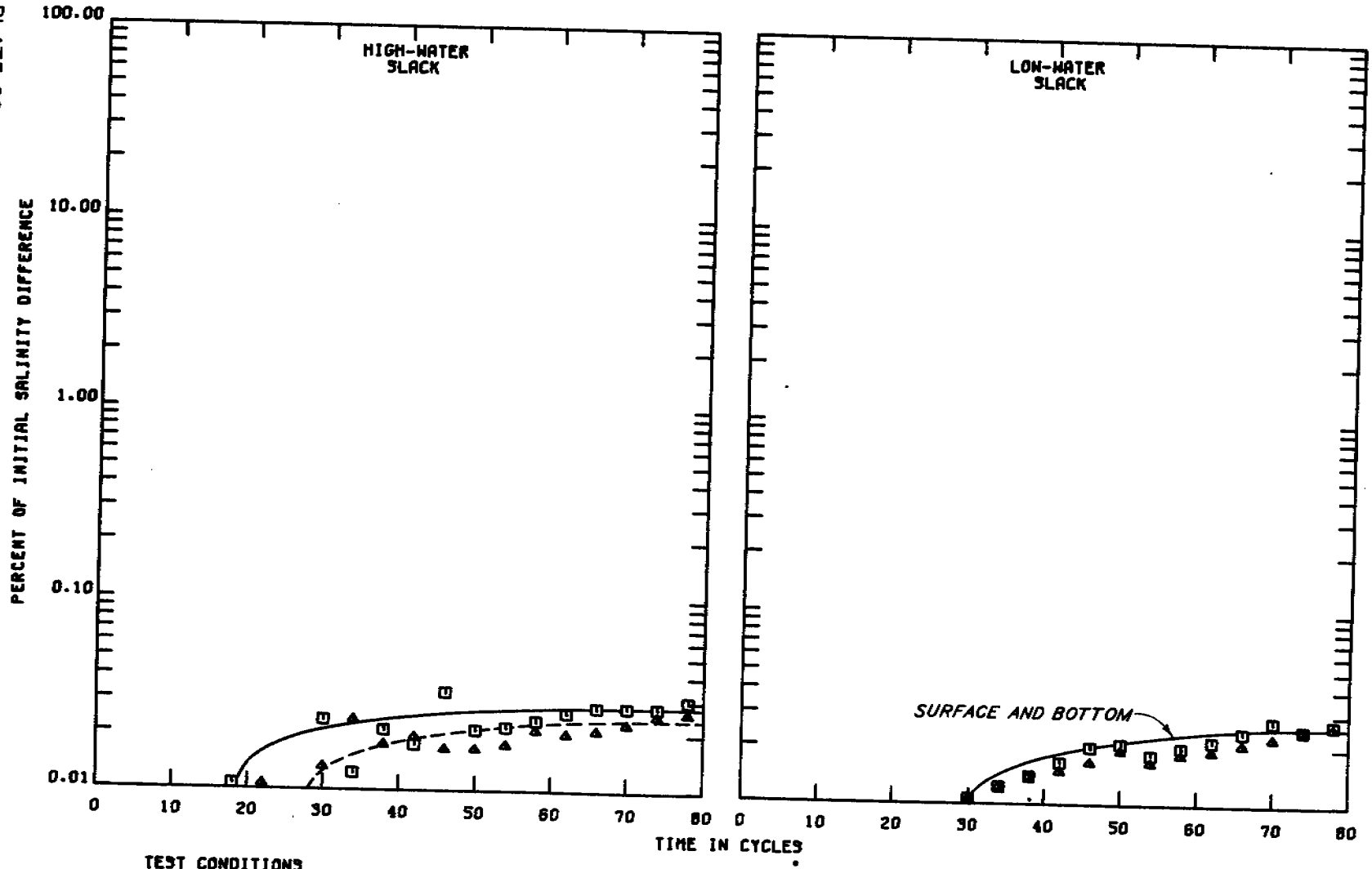
SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION E81

PLATE 85

PLATE 86



TEST CONDITIONS

FRESH-WATER DISCHARGE	11323 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

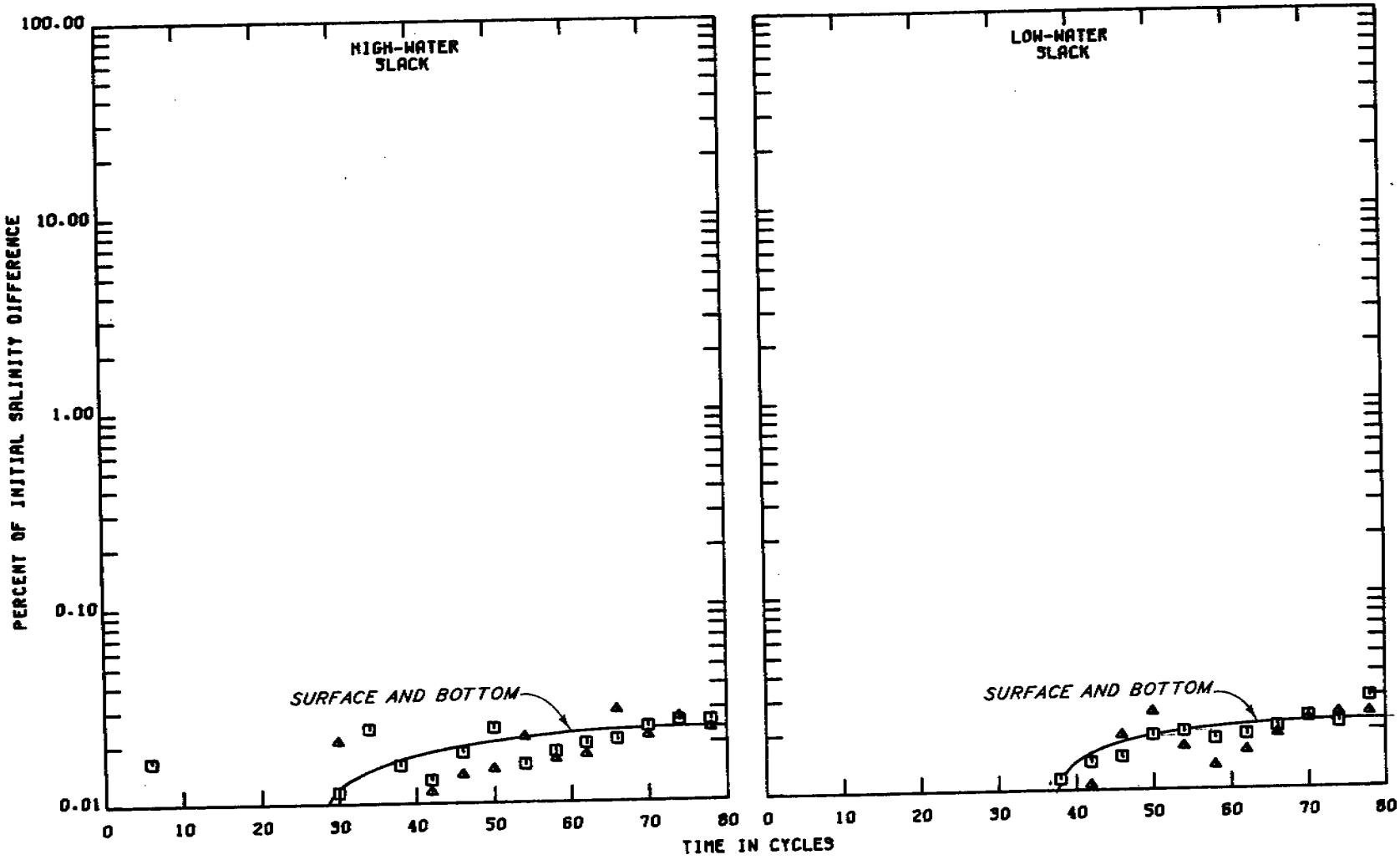
▲ – – – BOTTOM

GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION E82



TEST CONDITIONS

FRESH-WATER DISCHARGE	11329 CFS
BASE SALINITY AT DIFFUSER	19.6 PPT
EFFLUENT SALINITY	31.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

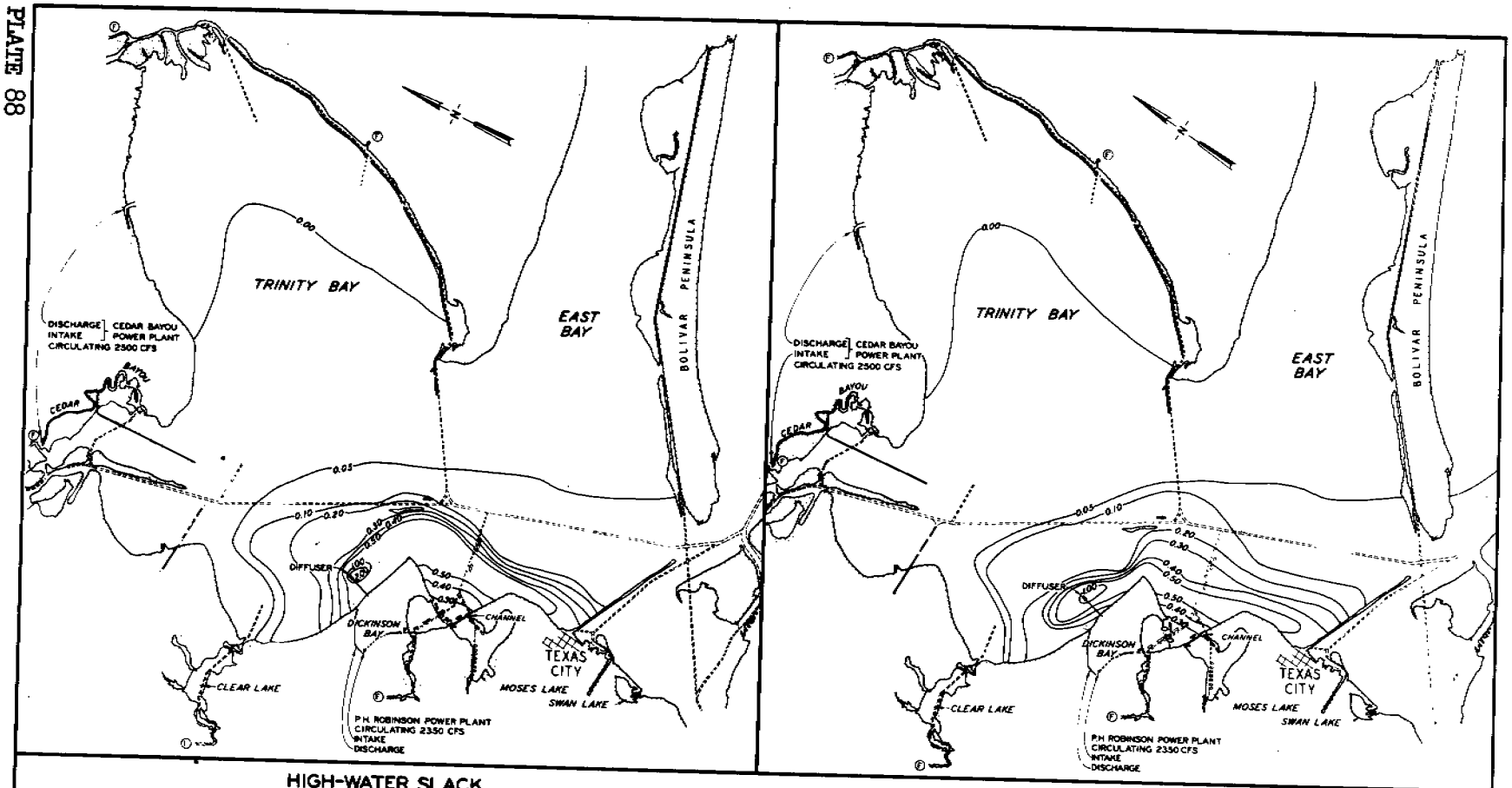
GALVESTON BAY MODEL

SALINE WATER DISPERSION TEST

10 MGD PLANT

STATION EB3

PLATE 87



HIGH-WATER SLACK

LOW-WATER SLACK

SCALES IN FEET

PROTOTYPE 6000 0 12,000 24,000 36,000

MODEL 10 0 10 20 30 40 50 60

NOTE: CONTOURS ARE IN PERCENT OF INITIAL EFFLUENT CONCENTRATION (11.4 PPT)

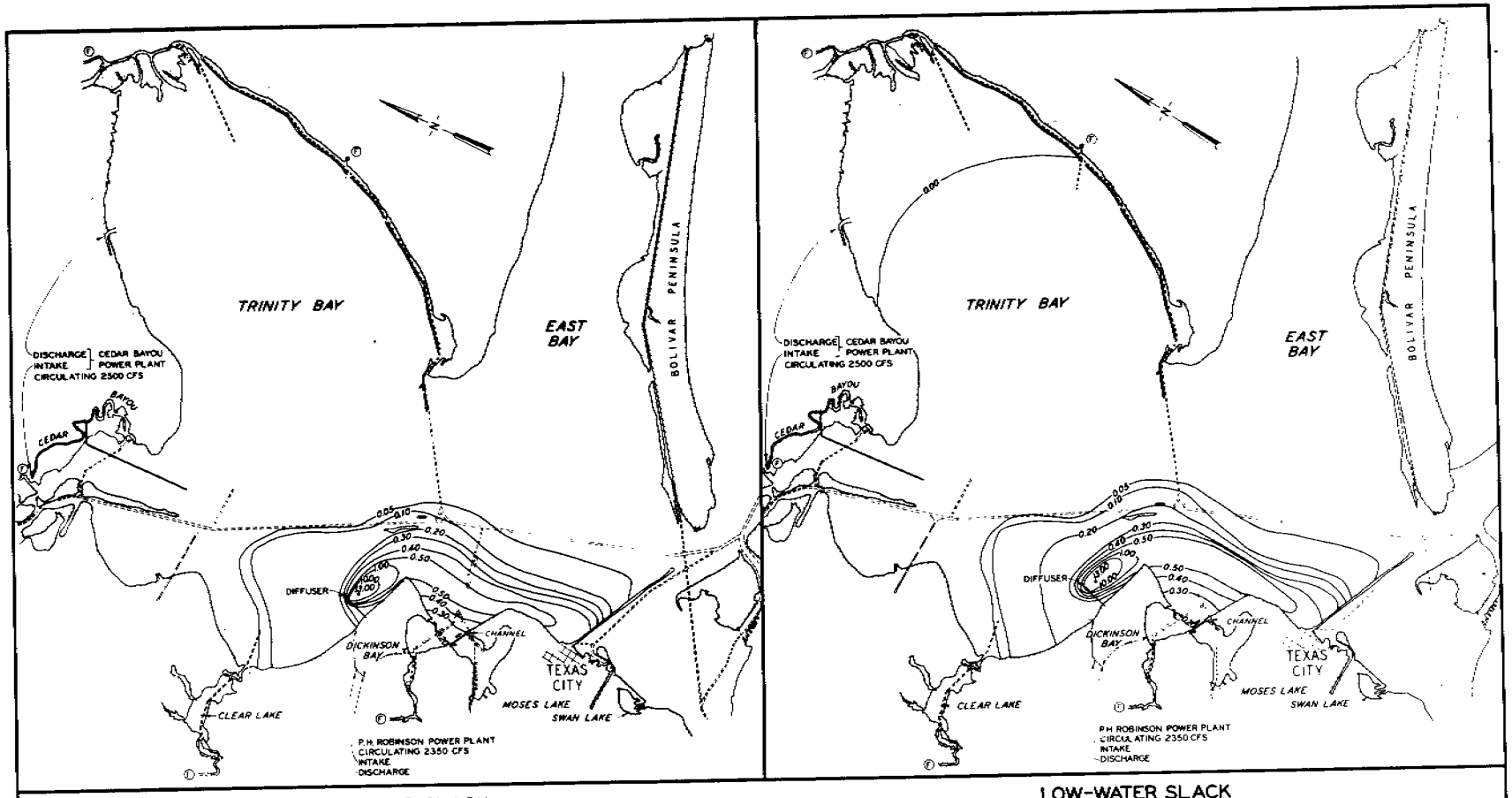
LEGEND

Ⓕ FRESHWATER INFLOW METER

OFFICE OF SALINE WATER STUDY
GALVESTON BAY MODEL

EFFLUENT DISPERSION PATTERNS

SURFACE DEPTH - CYCLE 80



NOTE: CONTOURS ARE IN PERCENT OF INITIAL SALINITY DIFFERENCE (11.4 PPT)

GALVESTON BAY MODEL

EFFLUENT DISPERSION PATTERNS

BOTTOM DEPTH - CYCLE 80

PLATE 89

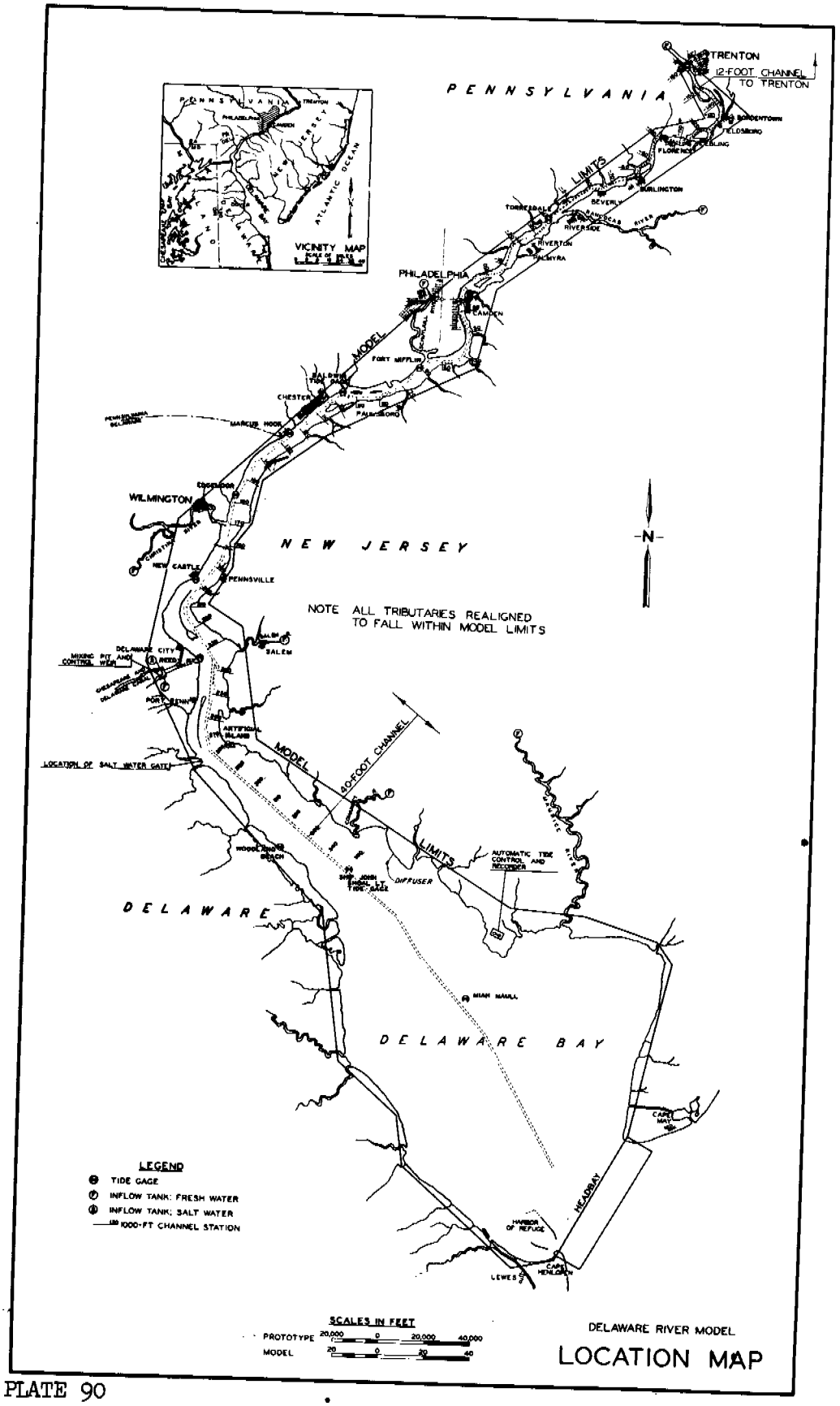

TRENTON
12-FOOT CHANNEL TO TRENTON
PENNSYLVANIA
MODEL LIMITS
BURLINGTON
BEVERLY
RIVERSIDE
RIVERTON
PALMYRA
PHILADELPHIA
CAMDEN
FORT MIFFLIN
CHESTER
MARCUS HOOK
WILMINGTON
EDGEMOOR
NEW CASTLE
PENNSVILLE
NEW JERSEY
NOTE ALL TRIBUTARIES REALIGNED TO FALL WITHIN MODEL LIMITS
SALEM
DELAWARE CITY
MIXING CONTROL PIT AND WEIR
PORT PENN
LOCATION OF SALT WATER GATE
40-FOOT CHANNEL
MODEL LIMITS
DIFFUSER
AUTOMATIC TIDE CONTROL AND RECORDER
DELAWARE
MIAH MAULL
DELAWARE BAY
CAPE MAY
HEADWAY
HARBOR OF REFUGE
CAPE HENLOPEN
LEWES
N
VICINITY MAP
LEGEND
TIDE GAGE
INFLOW TANK: FRESH WATER
INFLOW TANK: SALT WATER
1000-FT CHANNEL STATION
SCALES IN FEET
PROTOTYPE 20,000 0 20,000 40,000
MODEL 20 0 20 40
DELAWARE RIVER MODEL
LOCATION MAP

PLATE 90

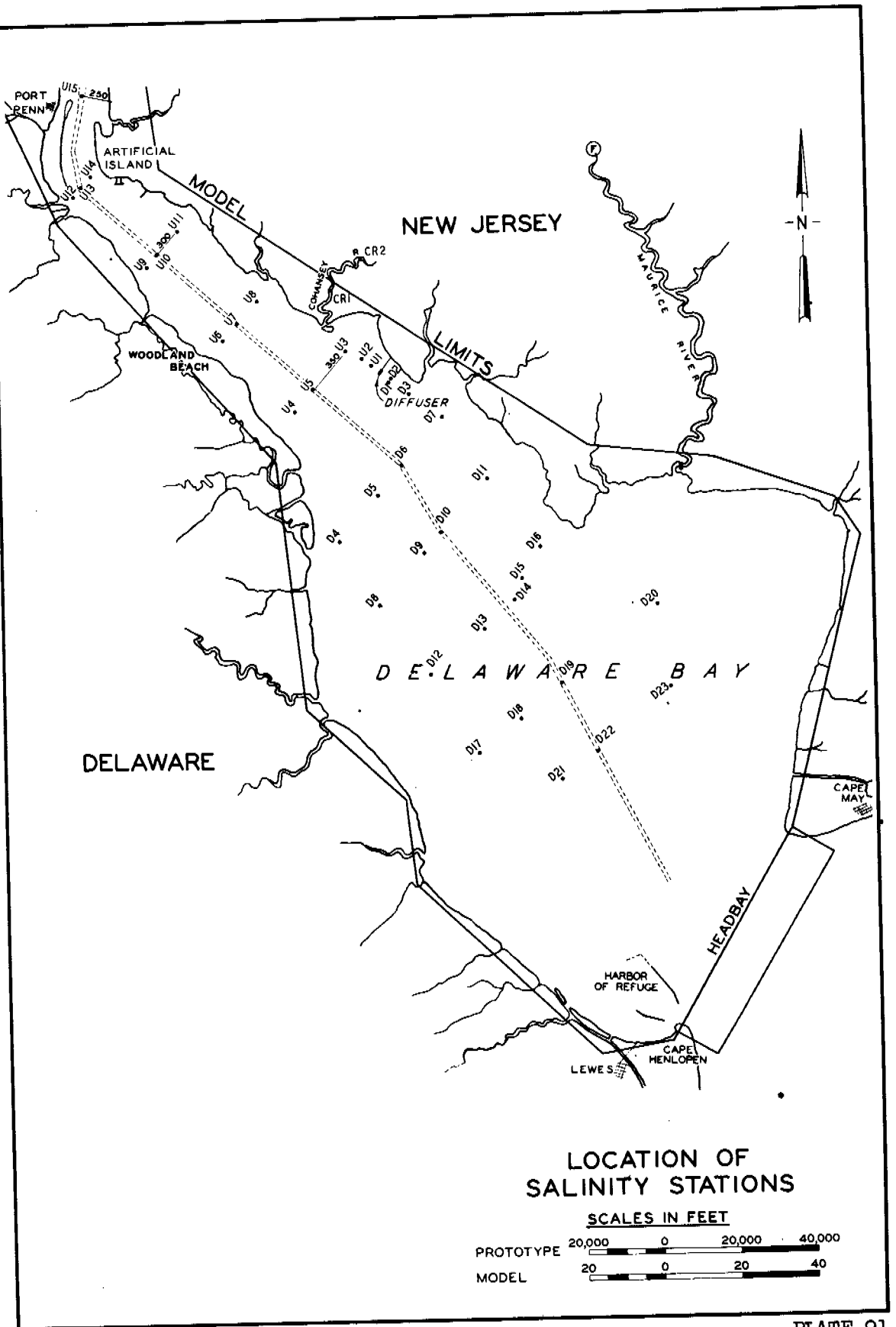
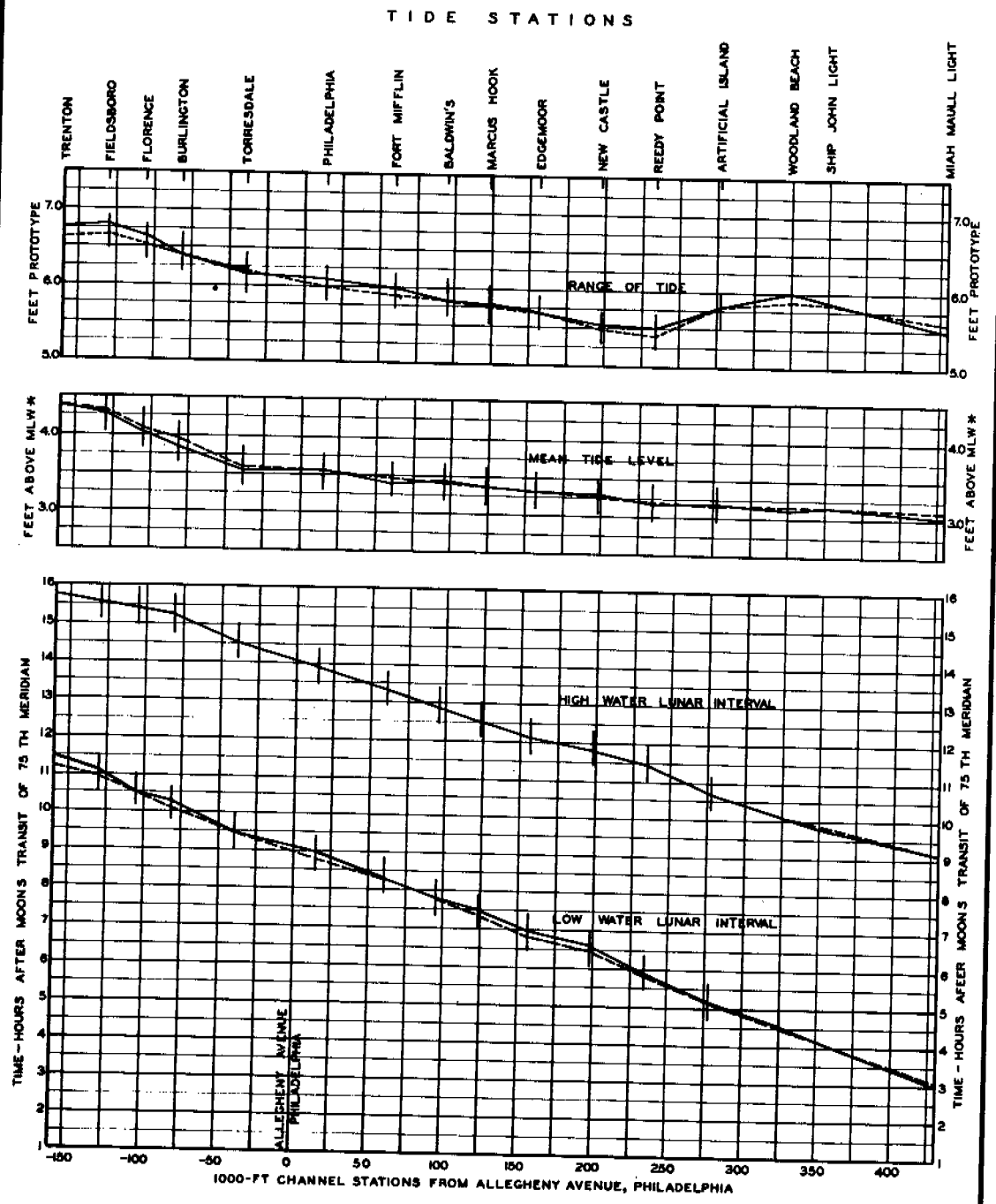

PORT PENN
ARTIFICIAL ISLAND II
MODEL LIMITS
NEW JERSEY
DELAWARE
WOODLAND BEACH
COMMISSEY CR1
CR2
MAURICE RIVER
DIFFUSER
DELAWARE BAY
CAPE MAY
HEADBAY
HARBOR OF REFUGE
CAPE HENLOPEN
LEWES
N
LOCATION OF SALINITY STATIONS
SCALES IN FEET
PROTOTYPE 20,000 0 20,000 40,000
MODEL 20 0 20 40

PLATE 91



MODEL TEST DATA

TIDE ..... MEAN
FRESH WATER DISCHARGE ... 20,200 CFS (MEAN AT CAPES)
OCEAN SALINITY ..... 31,000 PPM

LEGEND

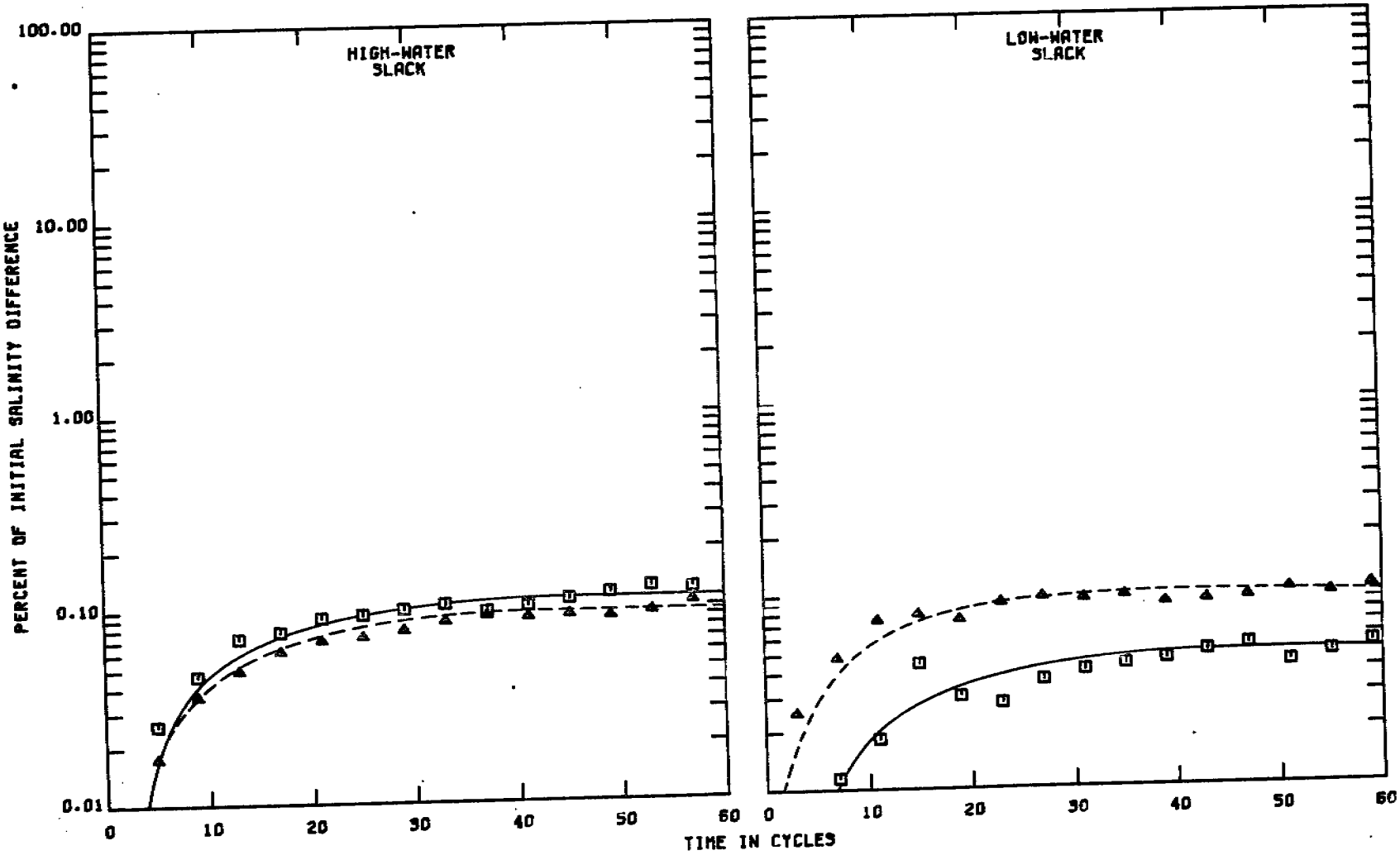
——— MODEL
——— PROTOTYPE

* HEIGHTS REFER TO DELAWARE RIVER DATUM WHICH IS 2.90 FEET BELOW MEAN SEA LEVEL SANDY HOOK, 1929 ADJUSTMENT.

DELAWARE RIVER MODEL

TIDAL OBSERVATIONS

PLATE 92



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

DELAWARE RIVER MODEL

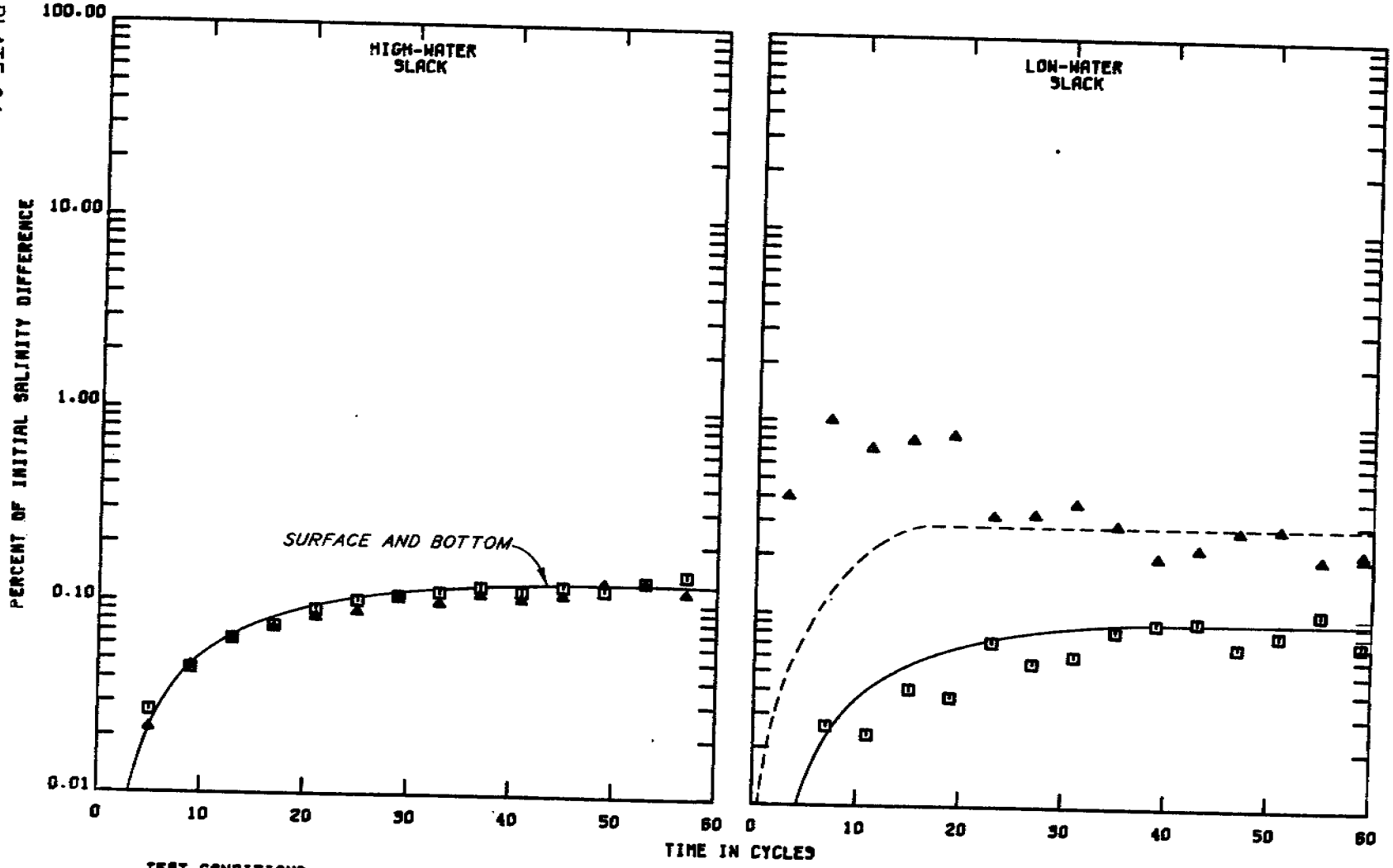
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D1

PLATE 93

PLATE 94



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

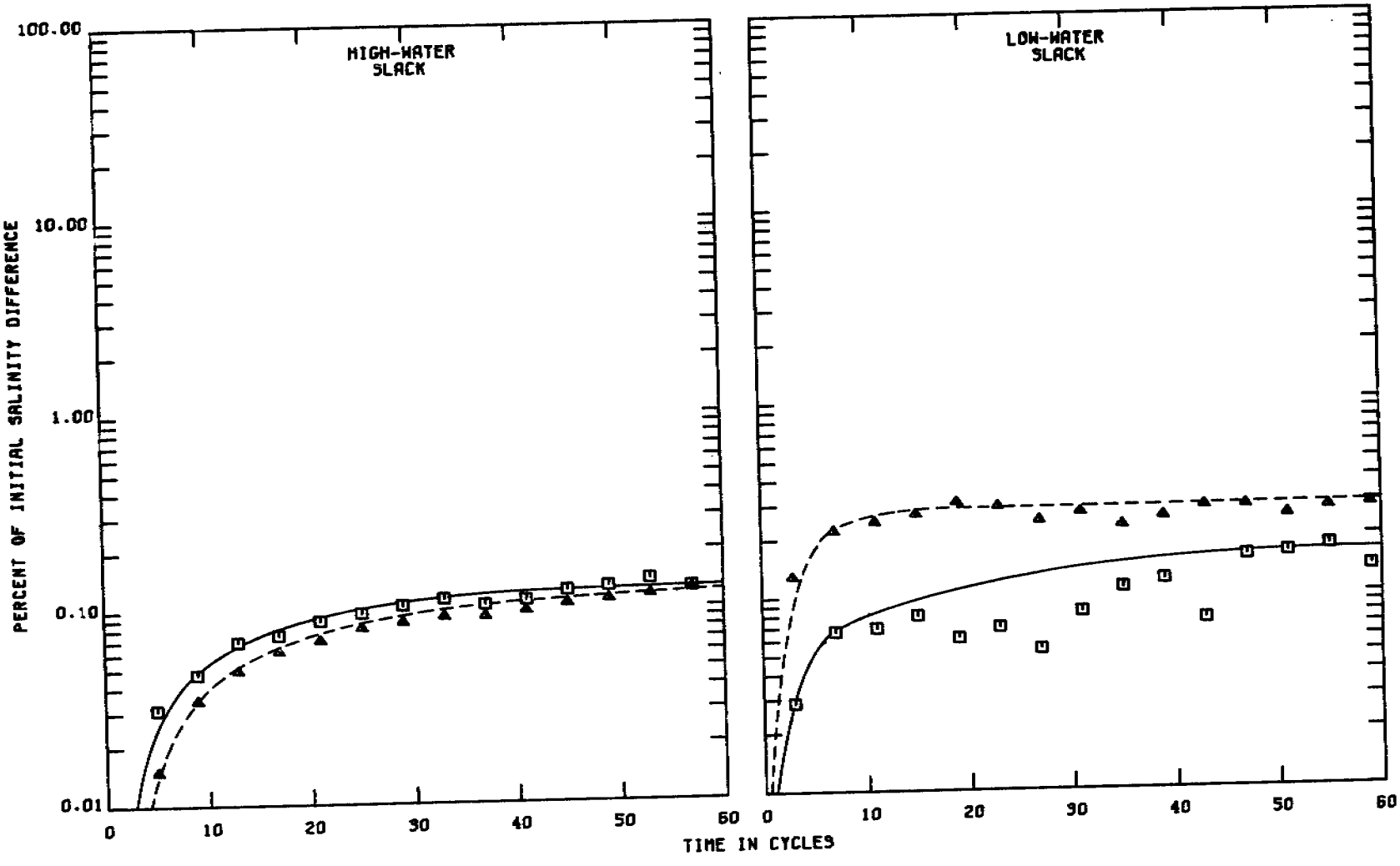
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D2



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

DELAWARE RIVER MODEL

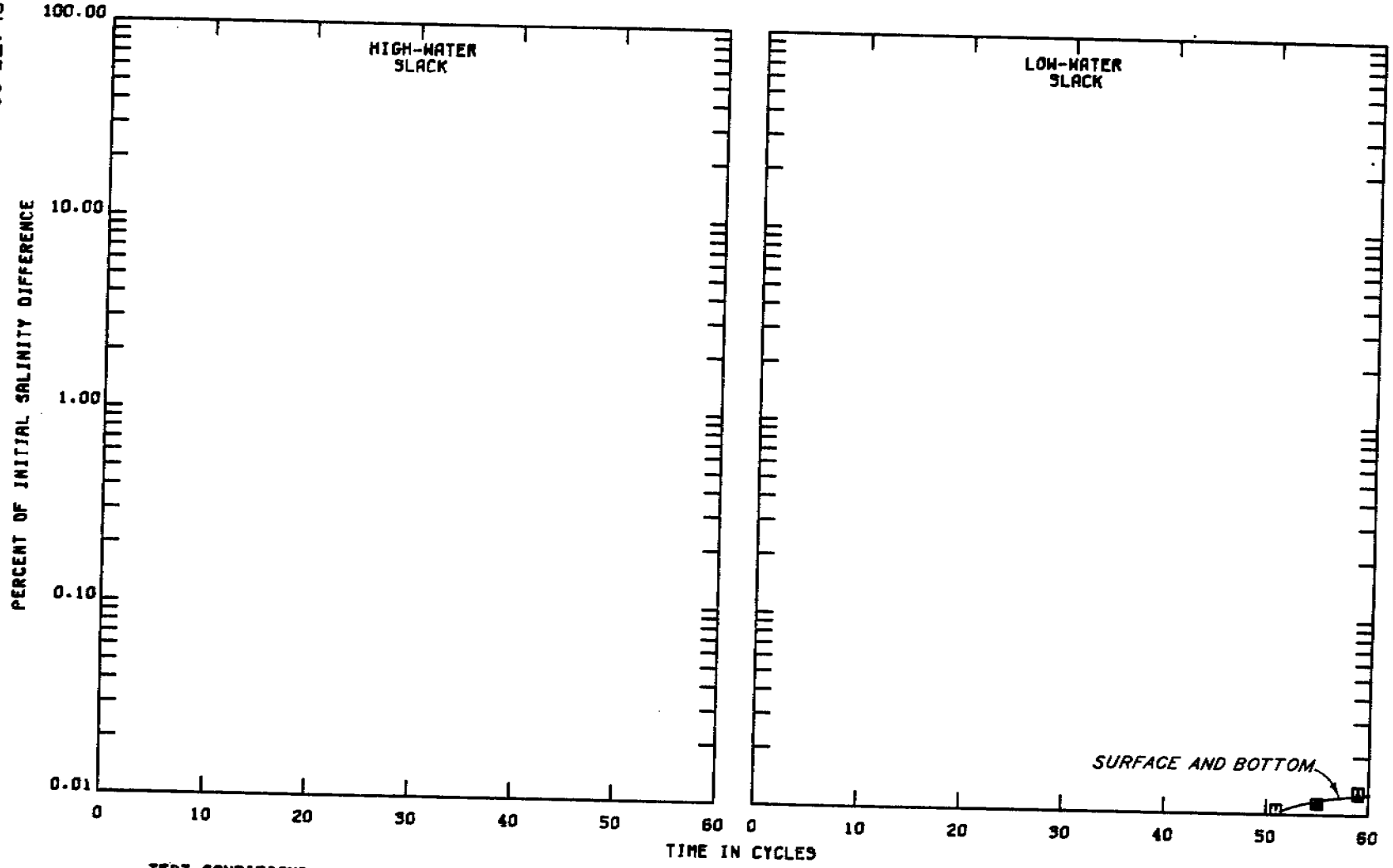
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D3

PLATE 95

PLATE 96



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

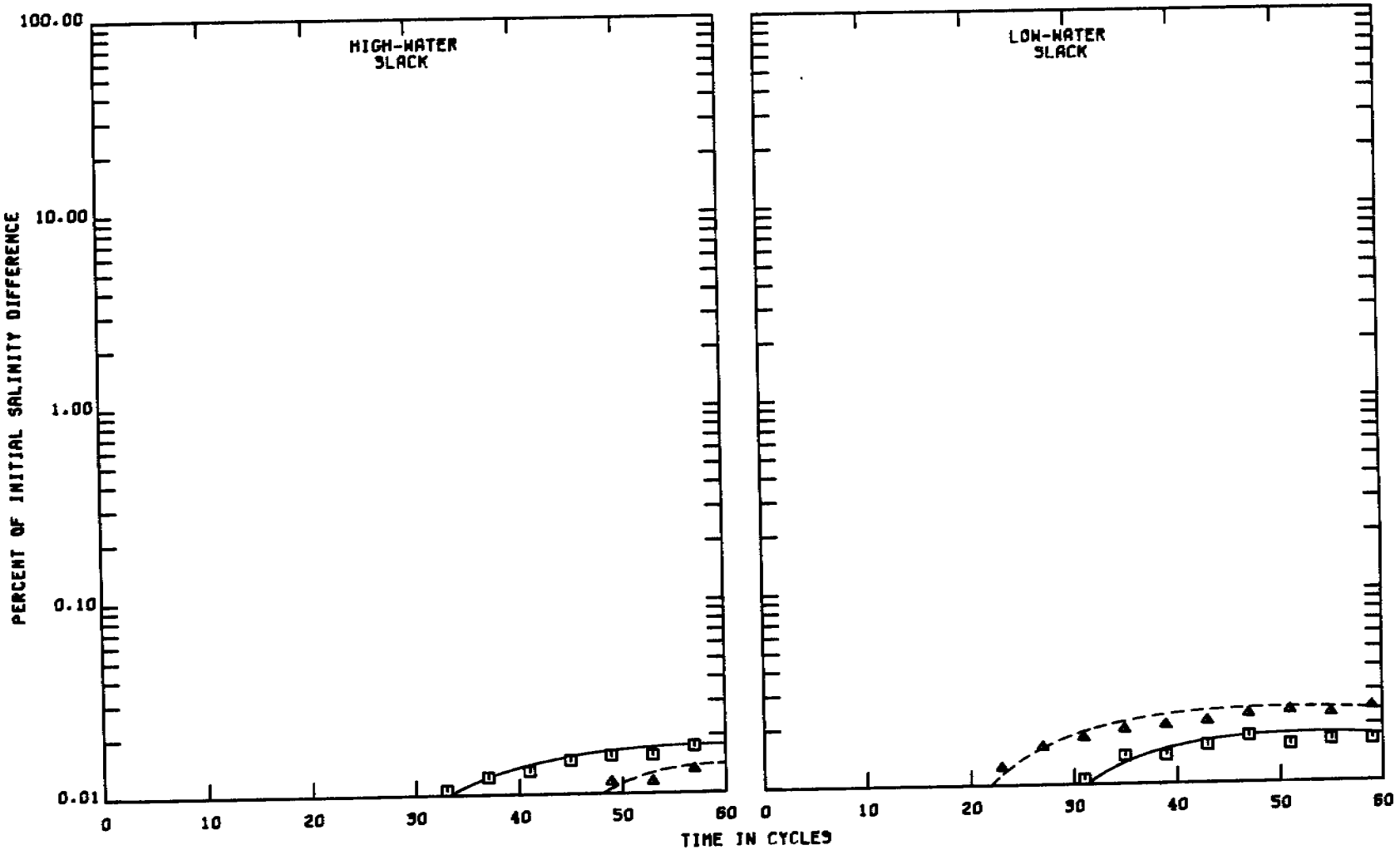
▲ — — — BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D4



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

BOTTOM

DELAWARE RIVER MODEL

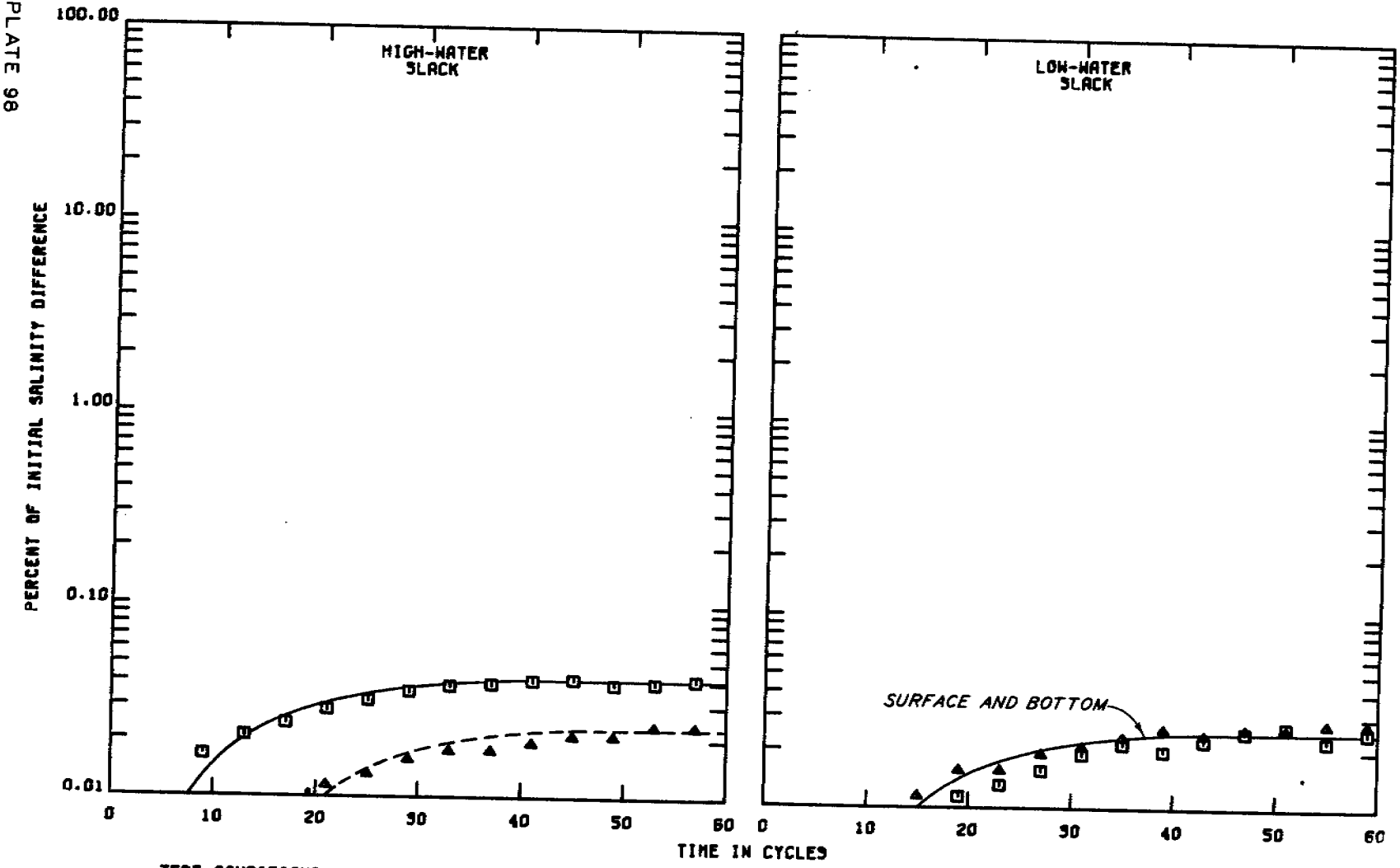
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D5

PLATE 97

PLATE 98



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

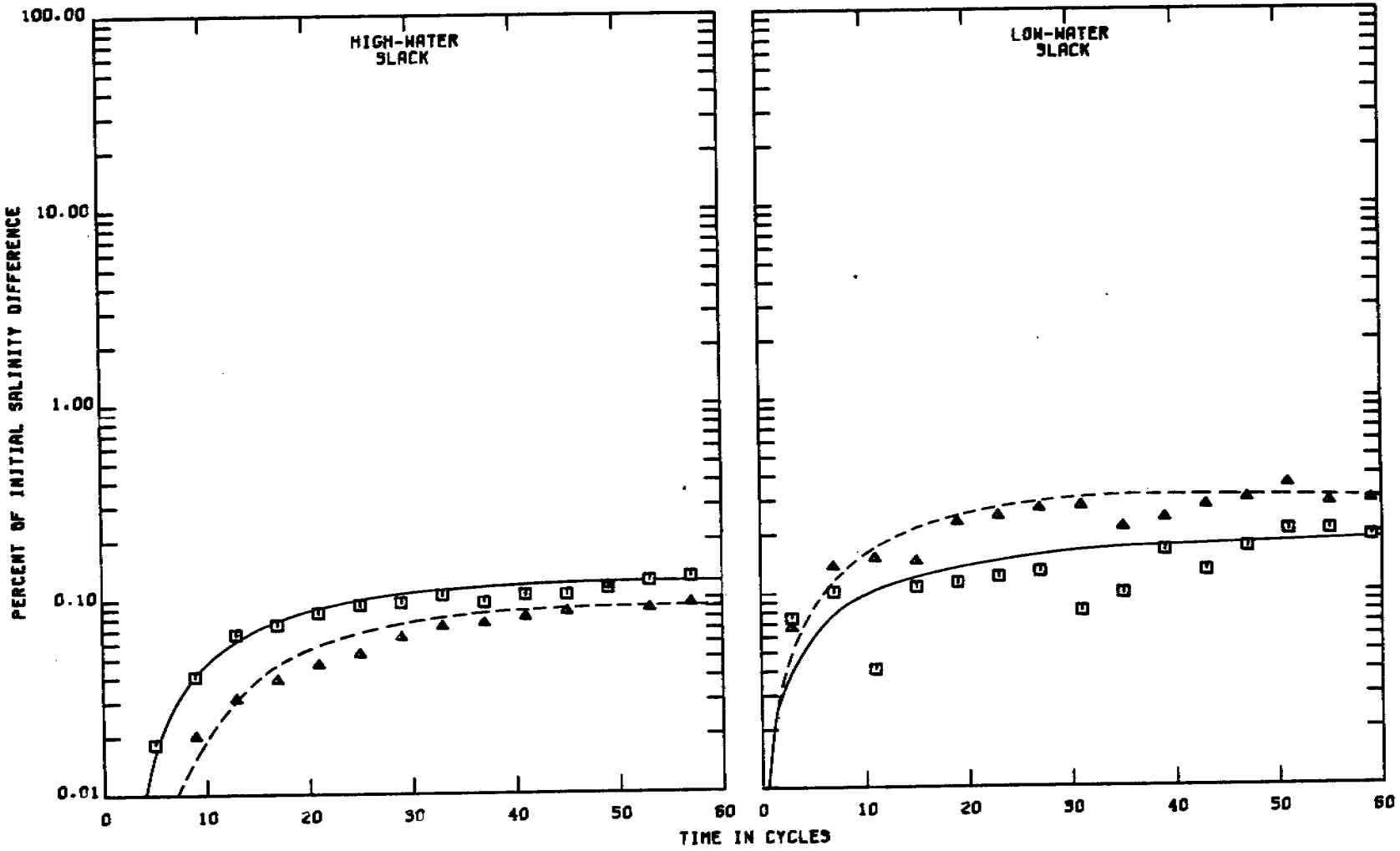
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D6



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

DELAWARE RIVER MODEL

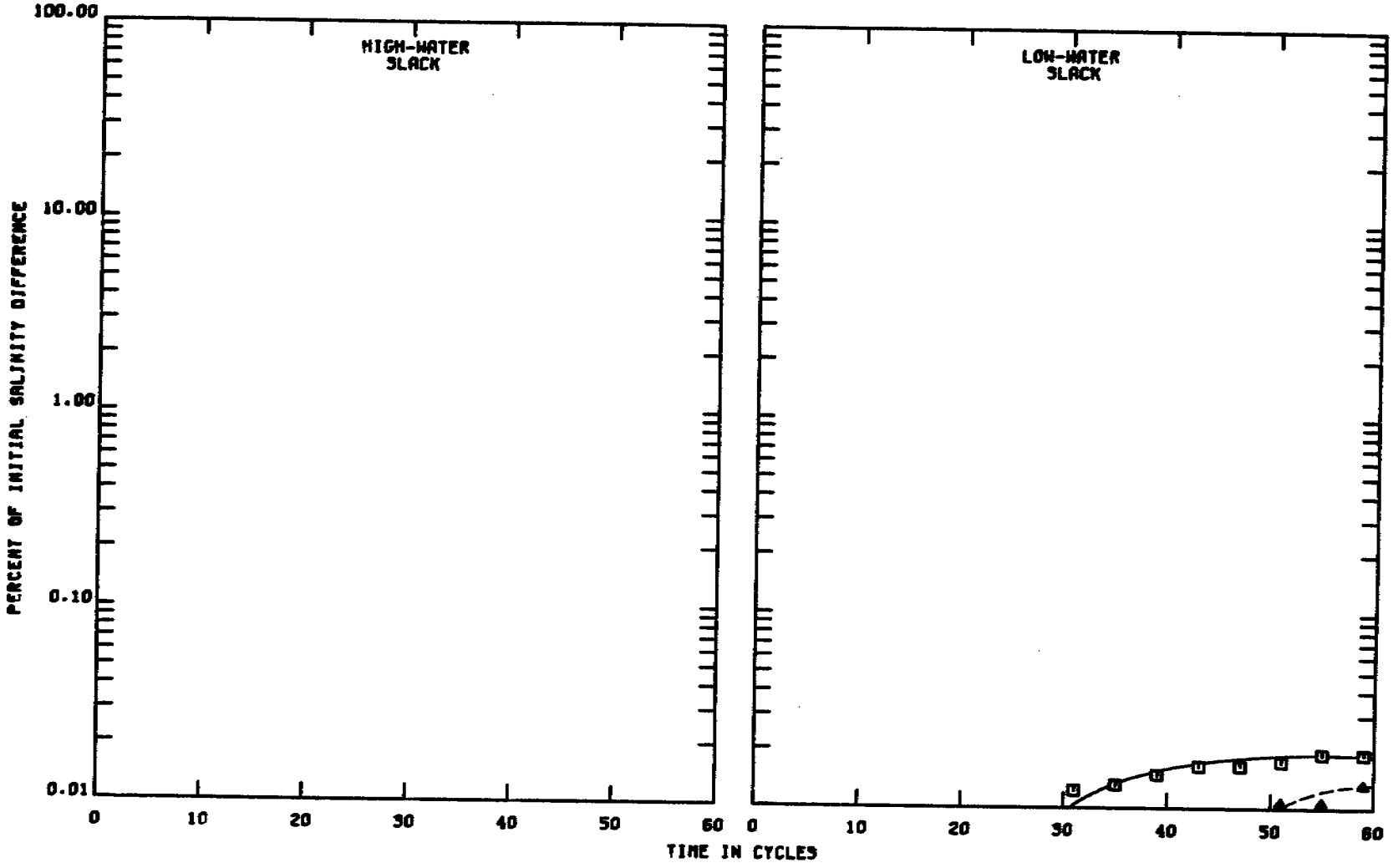
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D7

PLATE 99

PLATE 100



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

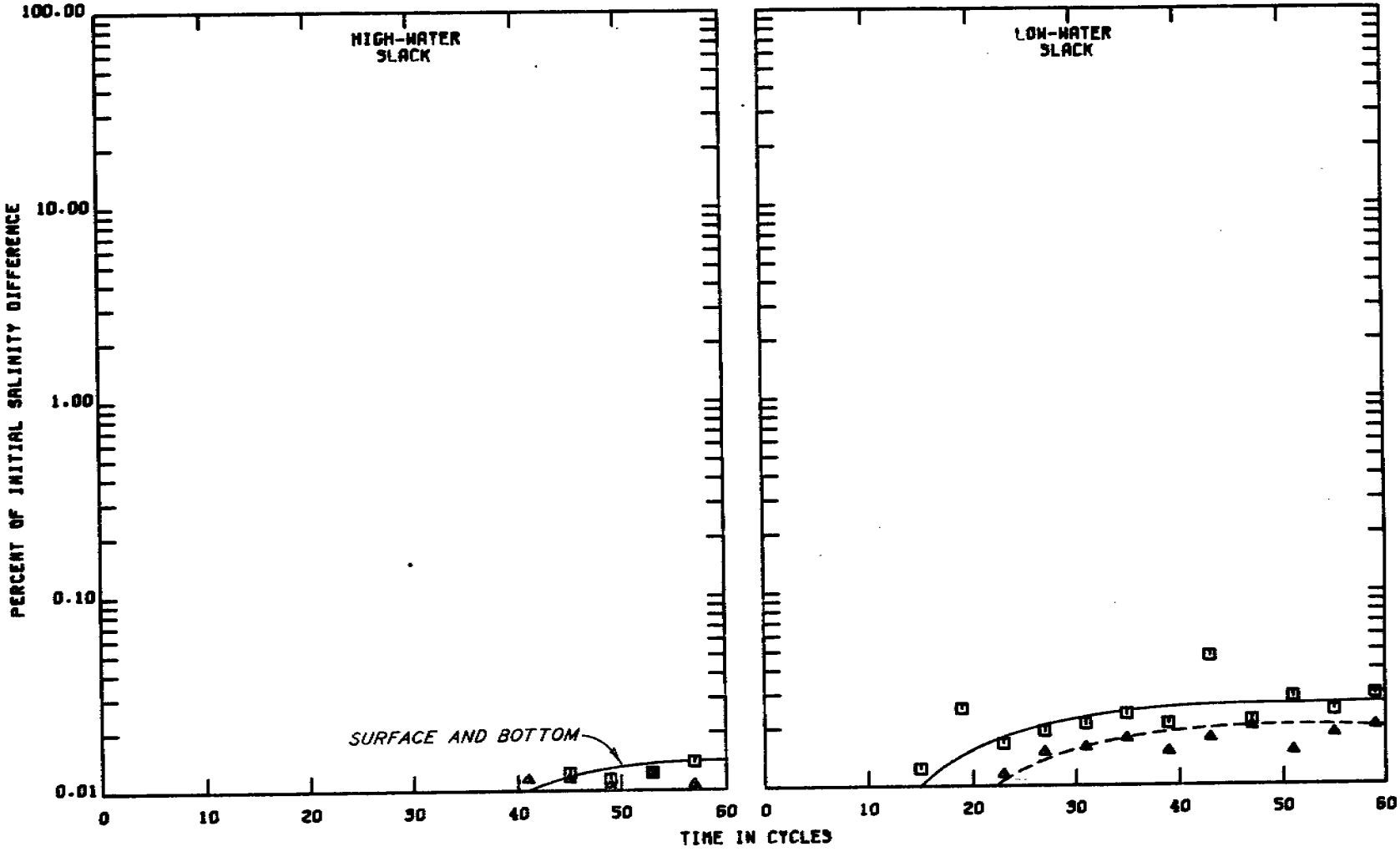
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D9



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

BOTTOM

DELAWARE RIVER MODEL

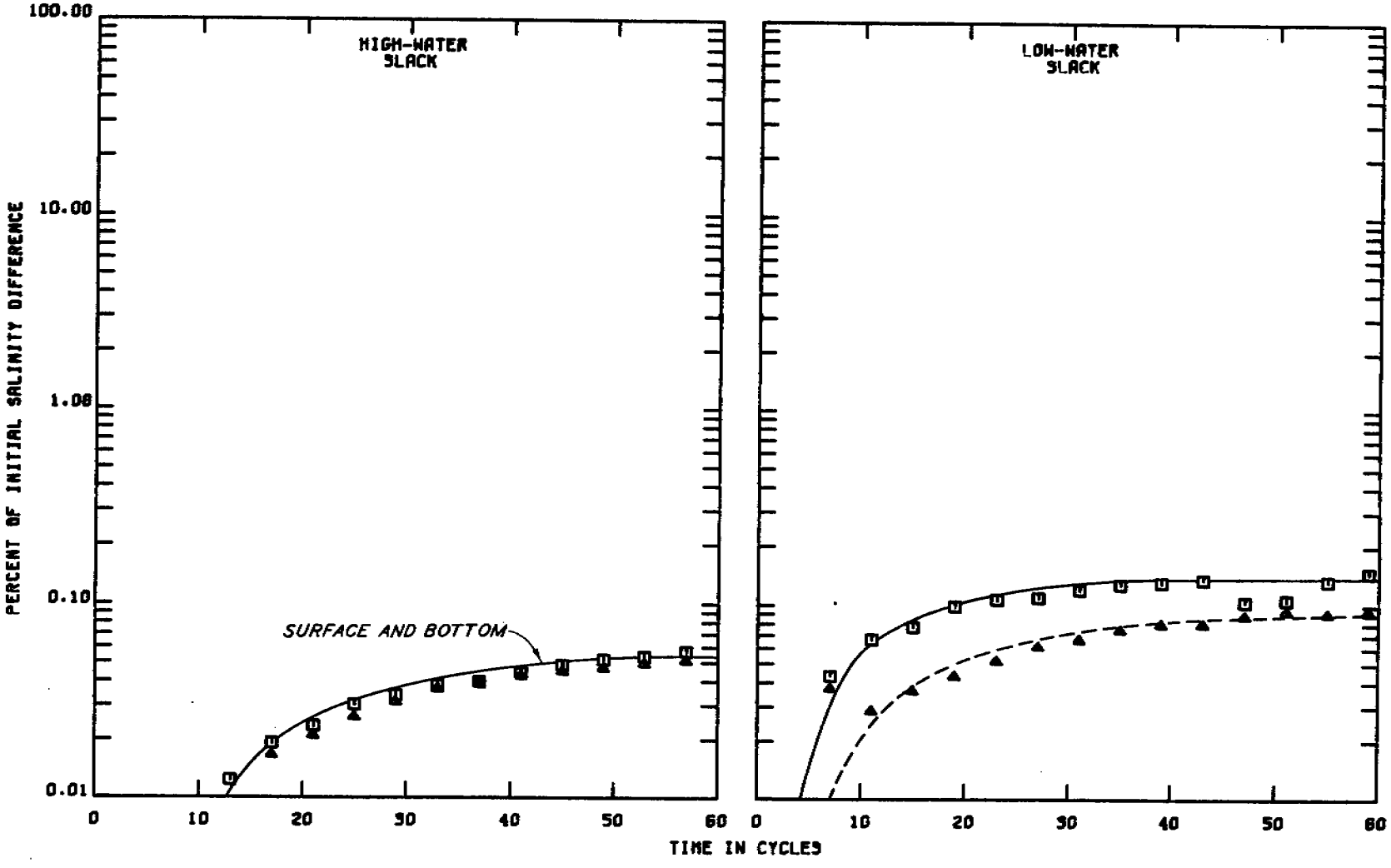
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D10

PLATE 101

PLATE 102



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

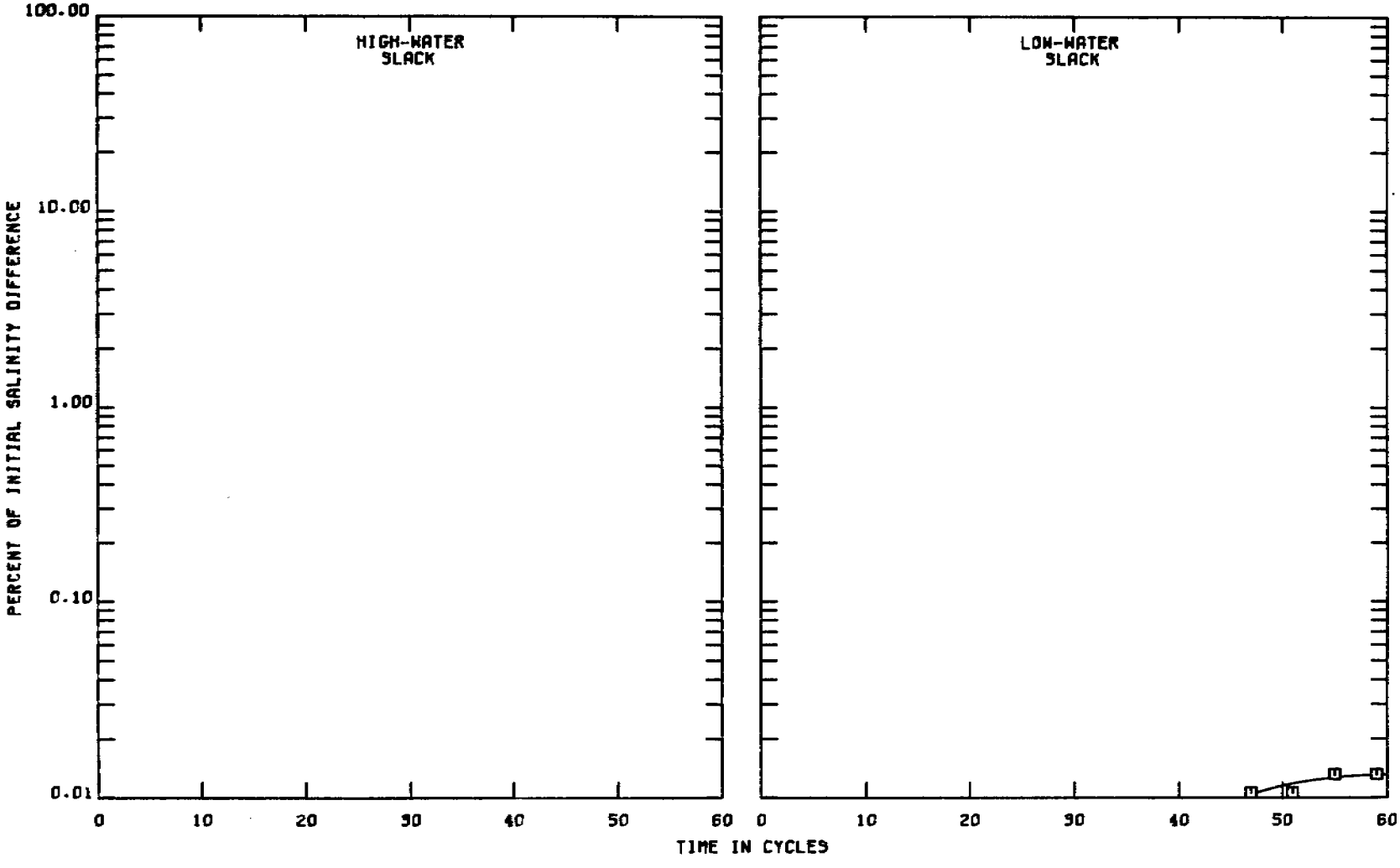
BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D11



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ — — — BOTTOM

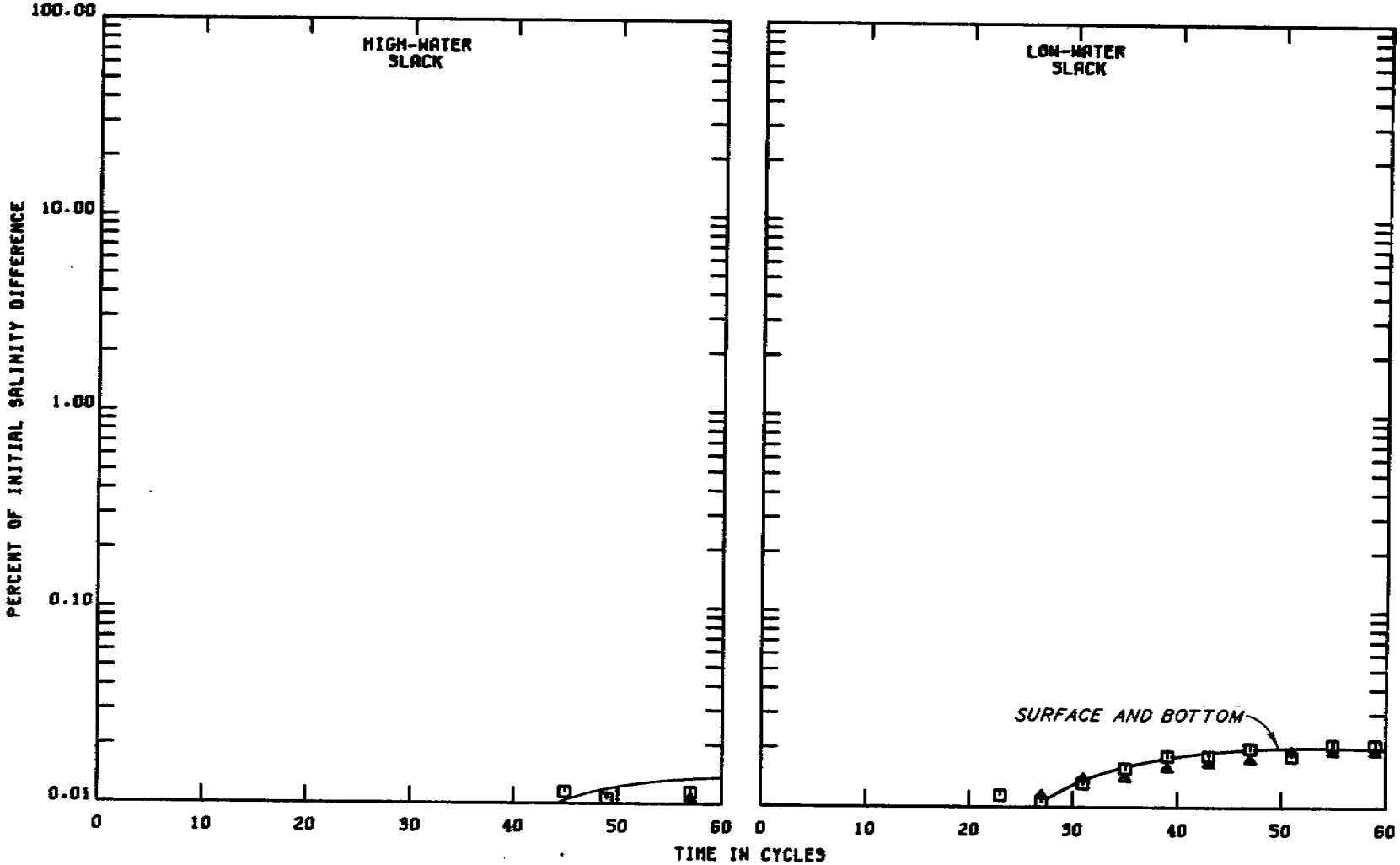
DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D13

PLATE 104



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

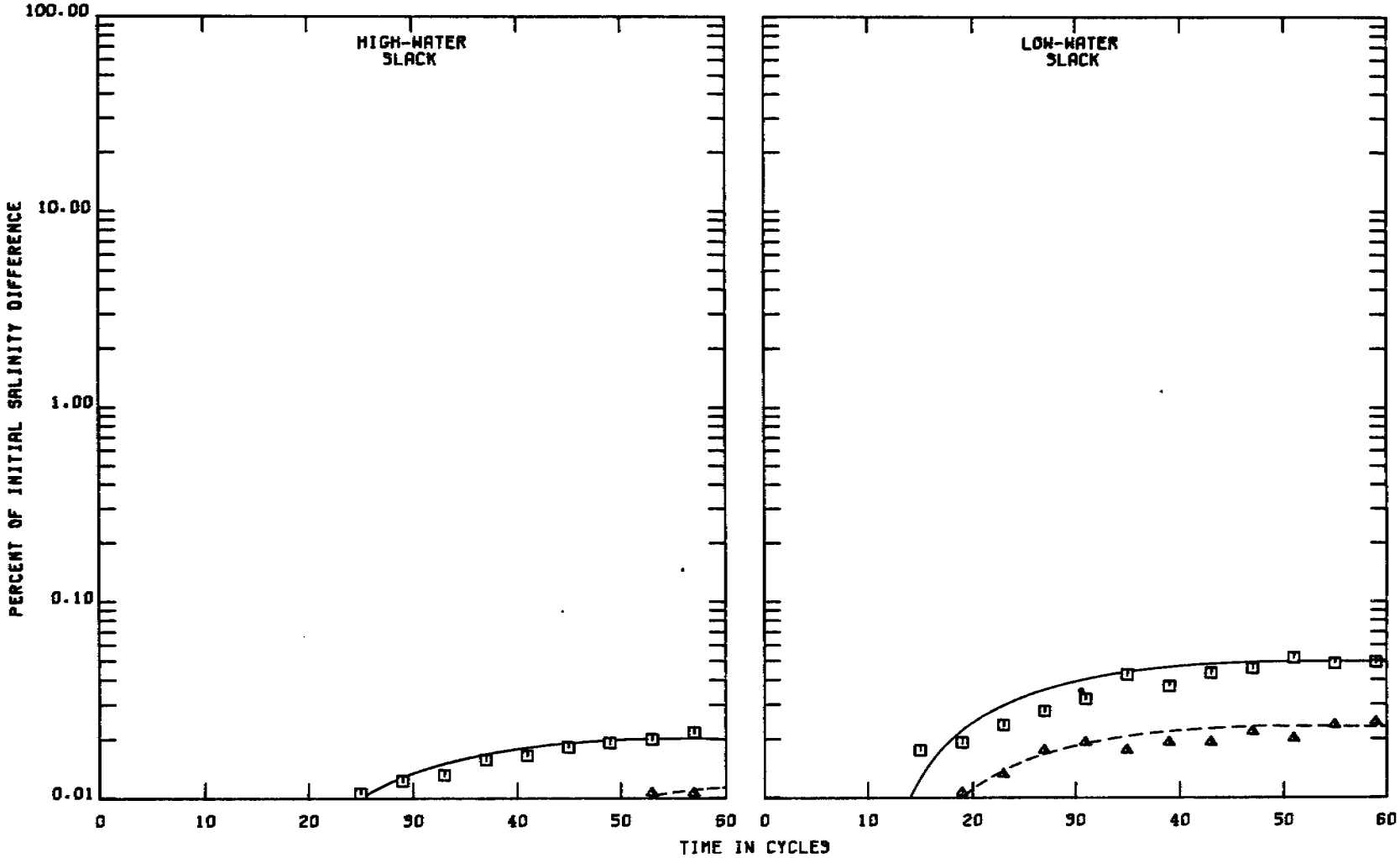
BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D14



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

DELAWARE RIVER MODEL

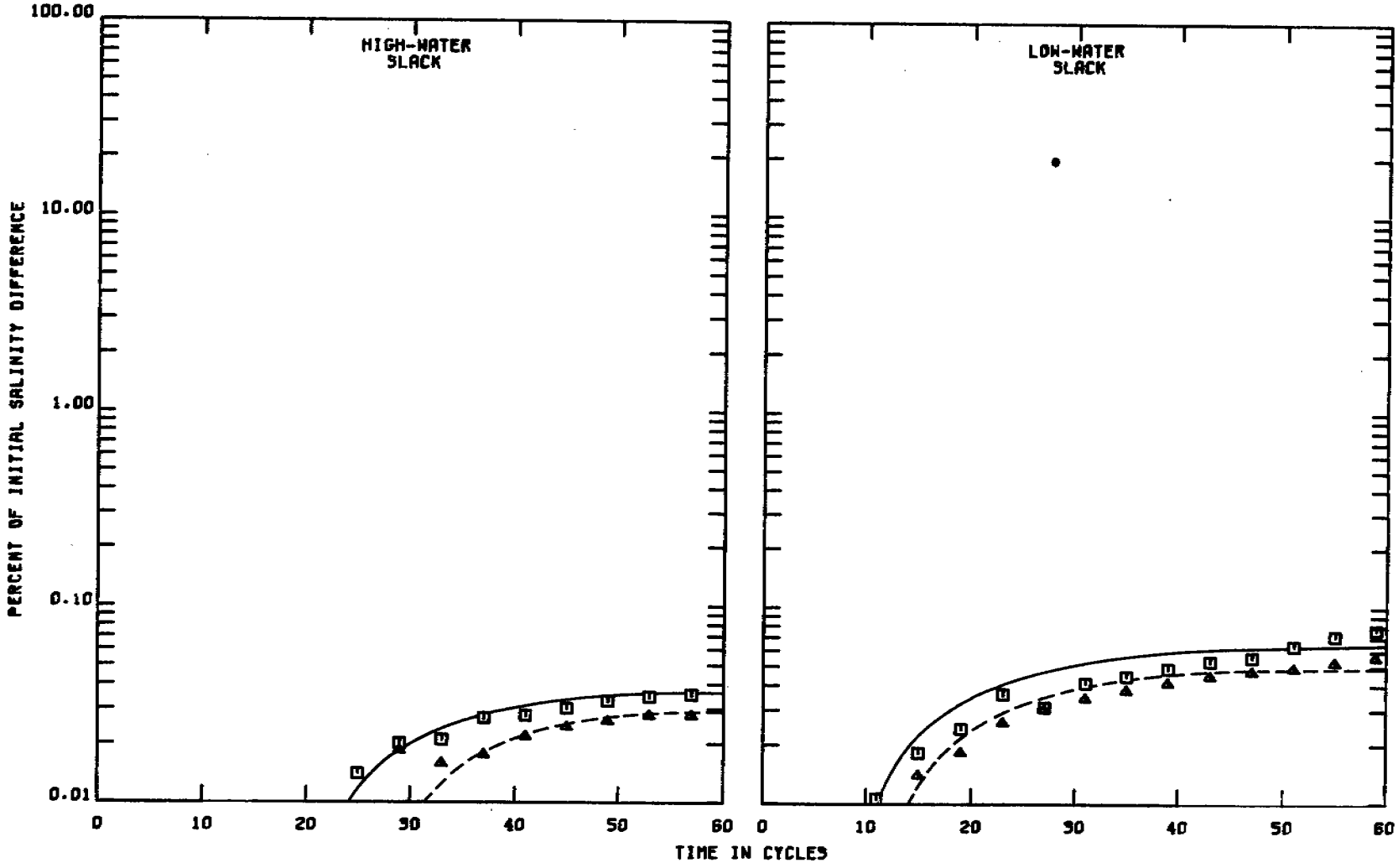
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D15

PLATE 105

PLATE 106



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

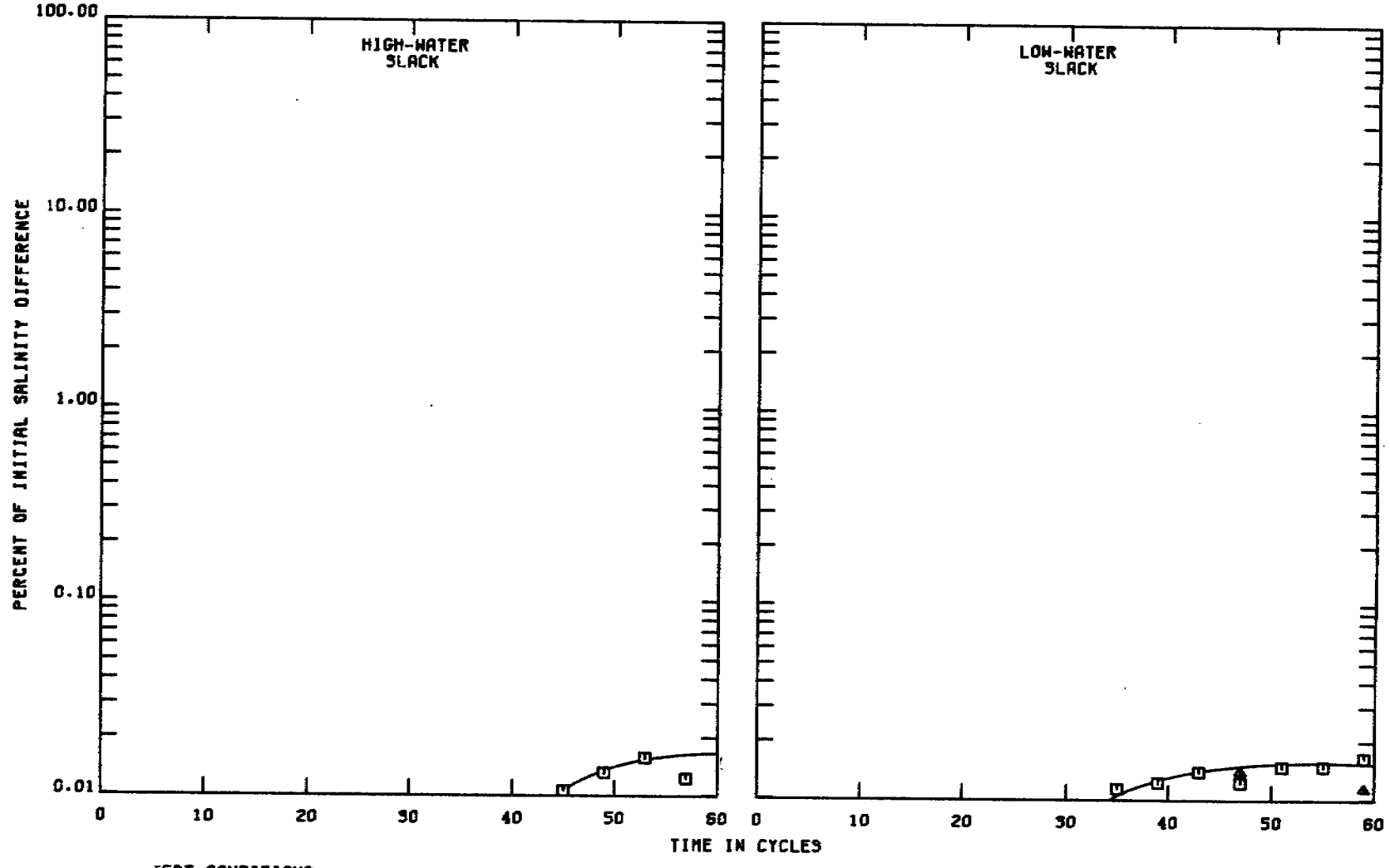
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D16



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

DELAWARE RIVER MODEL

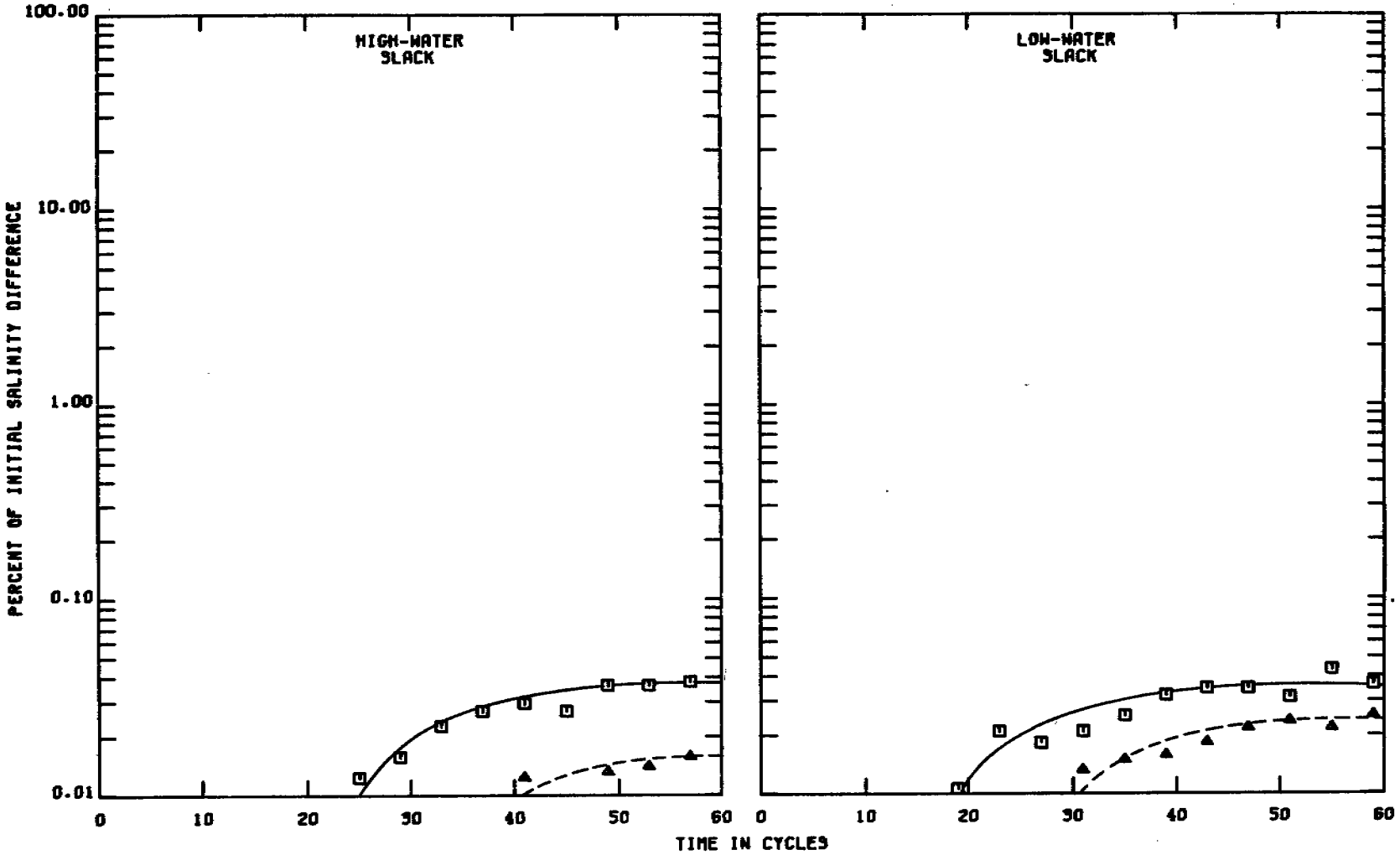
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D19

PLATE 107

PLATE 108



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

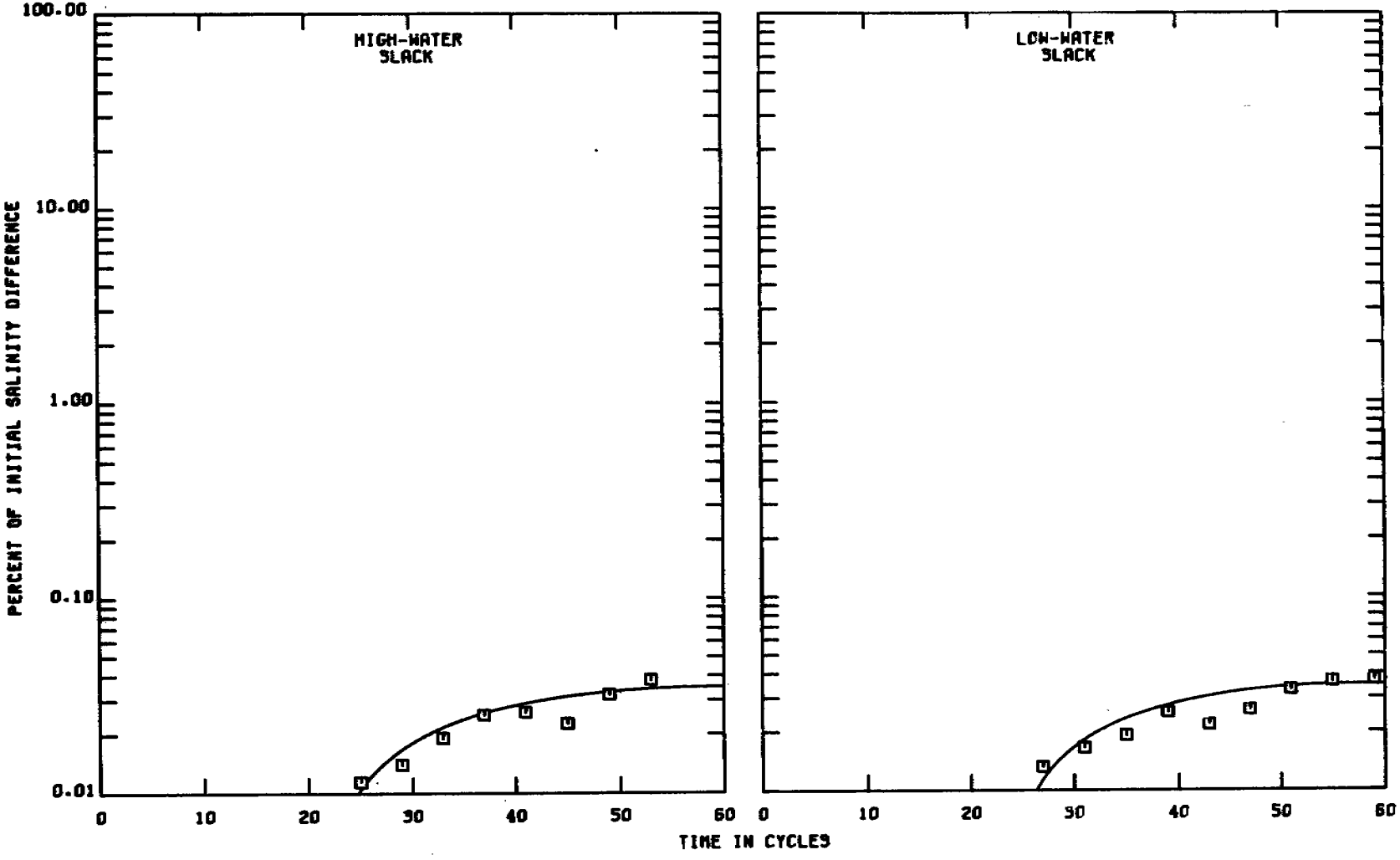
▲ - - - BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D20



TEST CONDITIONS	
FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ — — — BOTTOM

DELAWARE RIVER MODEL

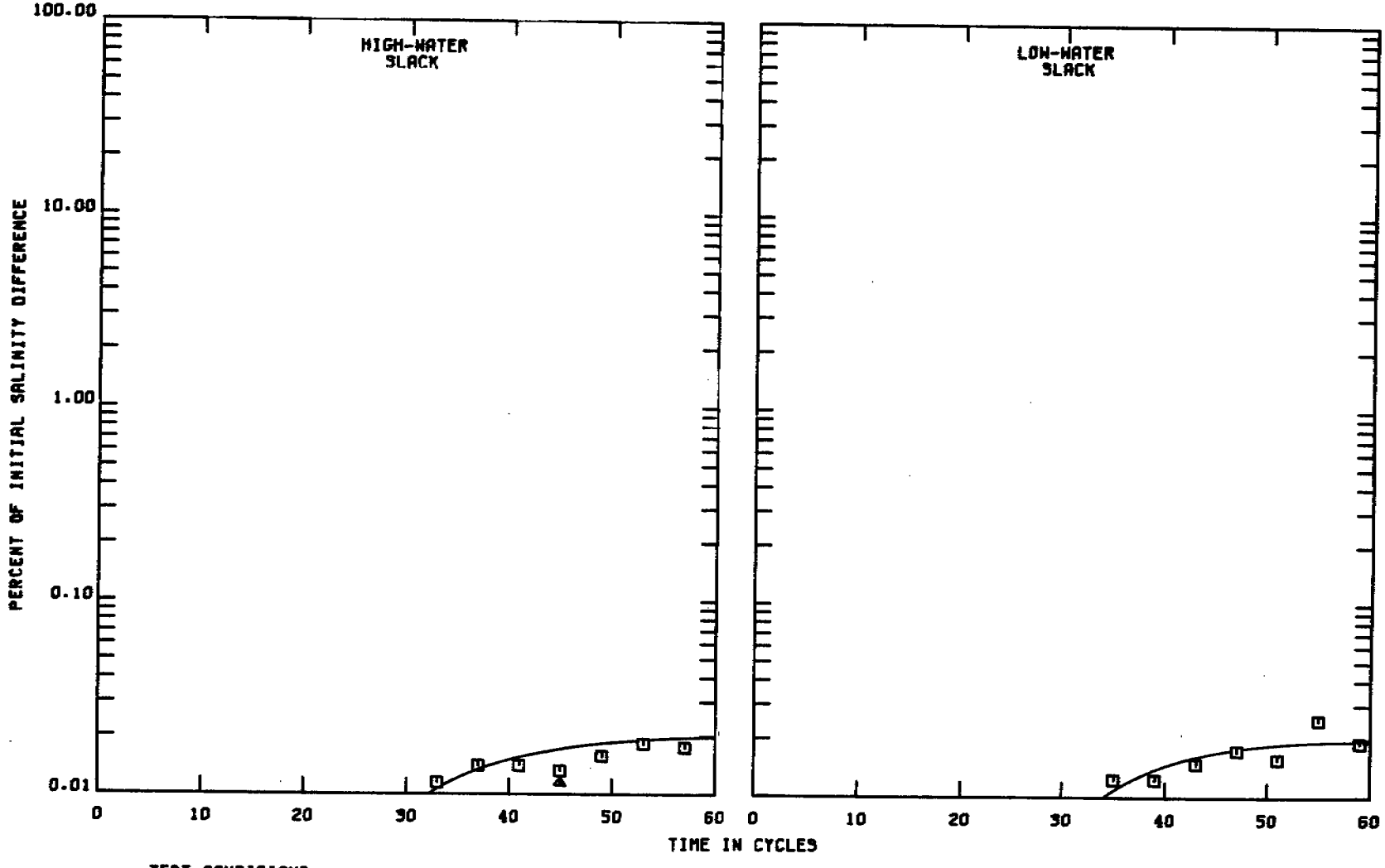
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D21

PLATE 109

PLATE 110



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

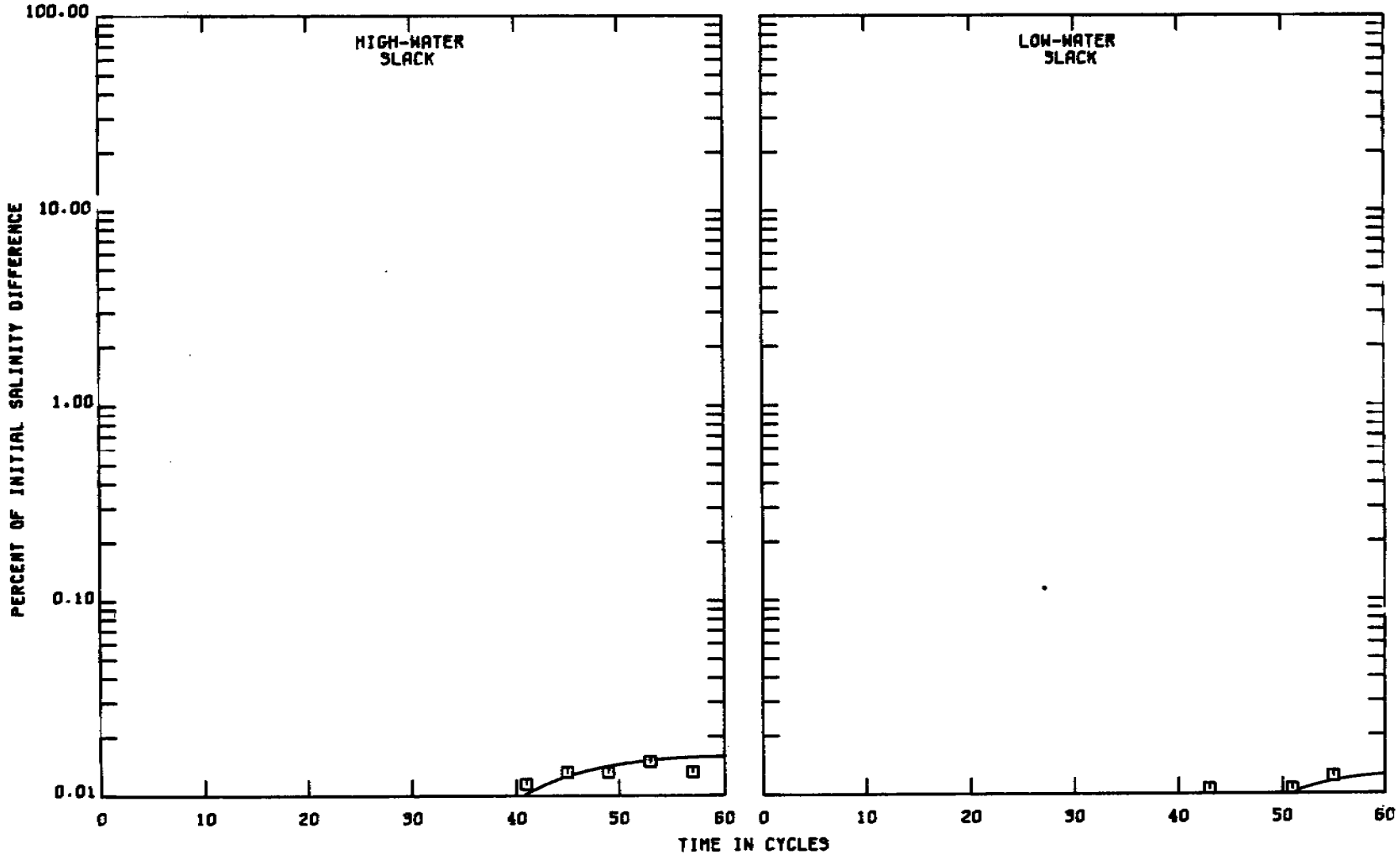
▲ — — — BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D22



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

DELAWARE RIVER MODEL

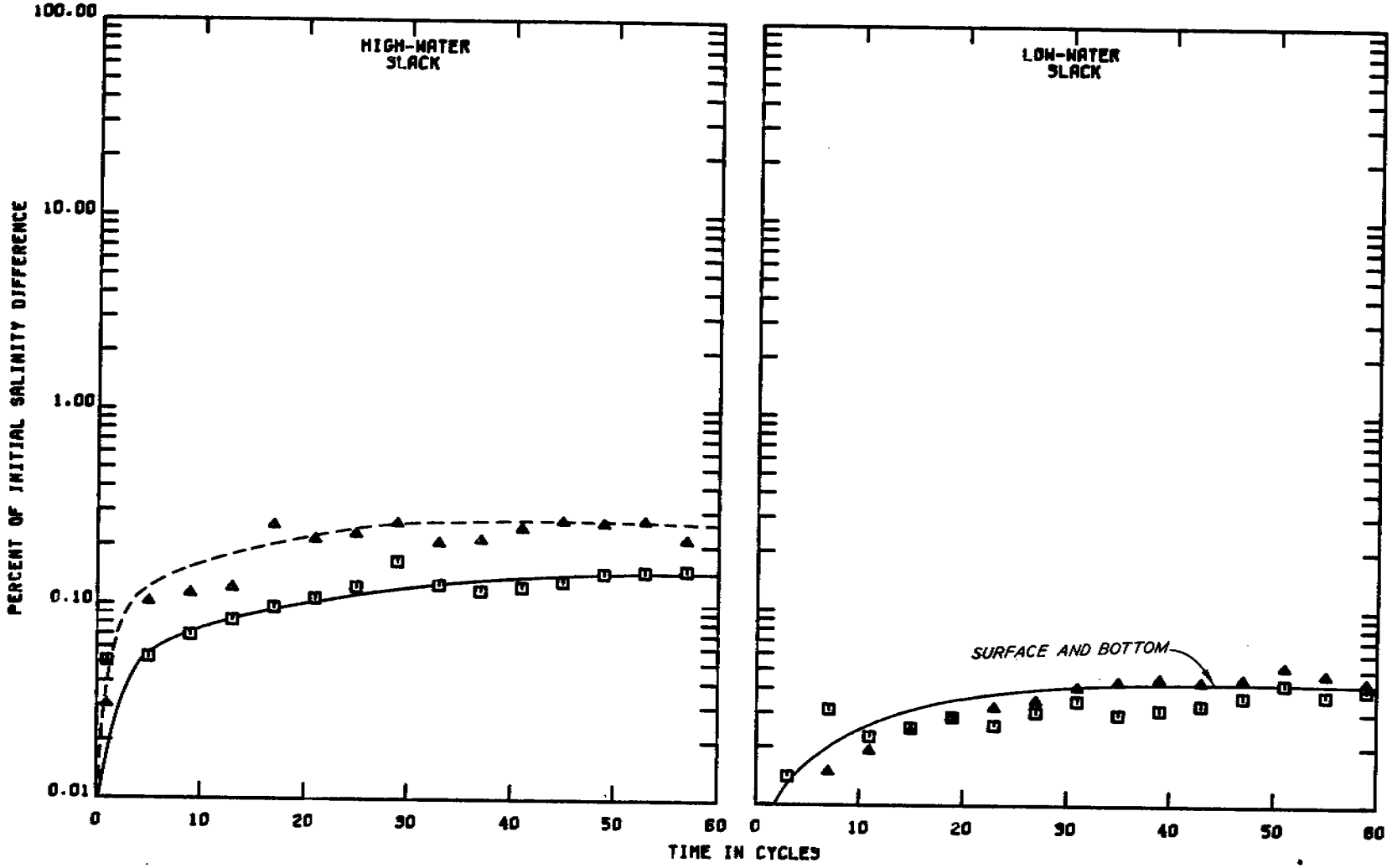
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION D23

PLATE III

PLATE 112



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

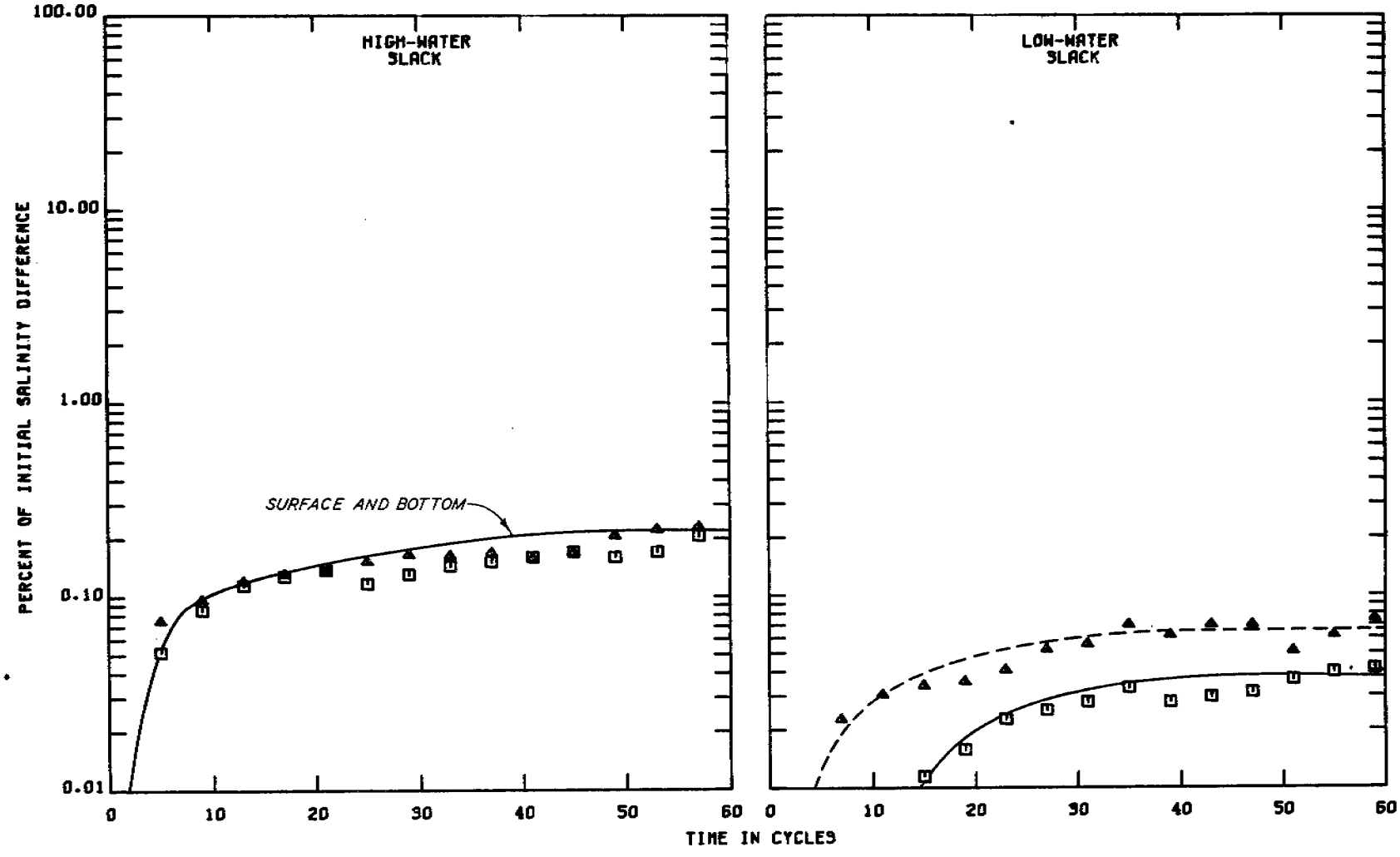
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U1



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

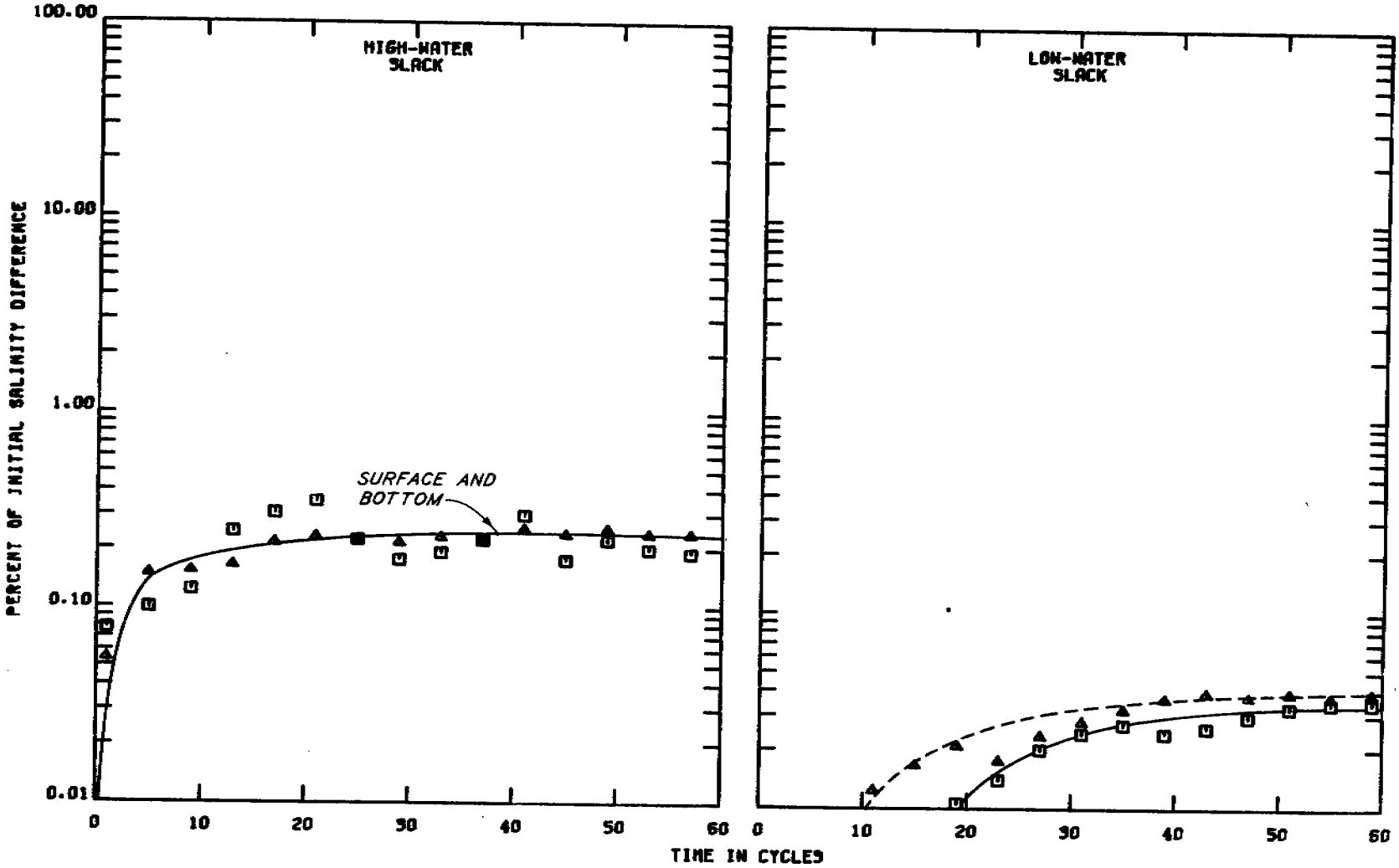
DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U2

PLATE 113



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

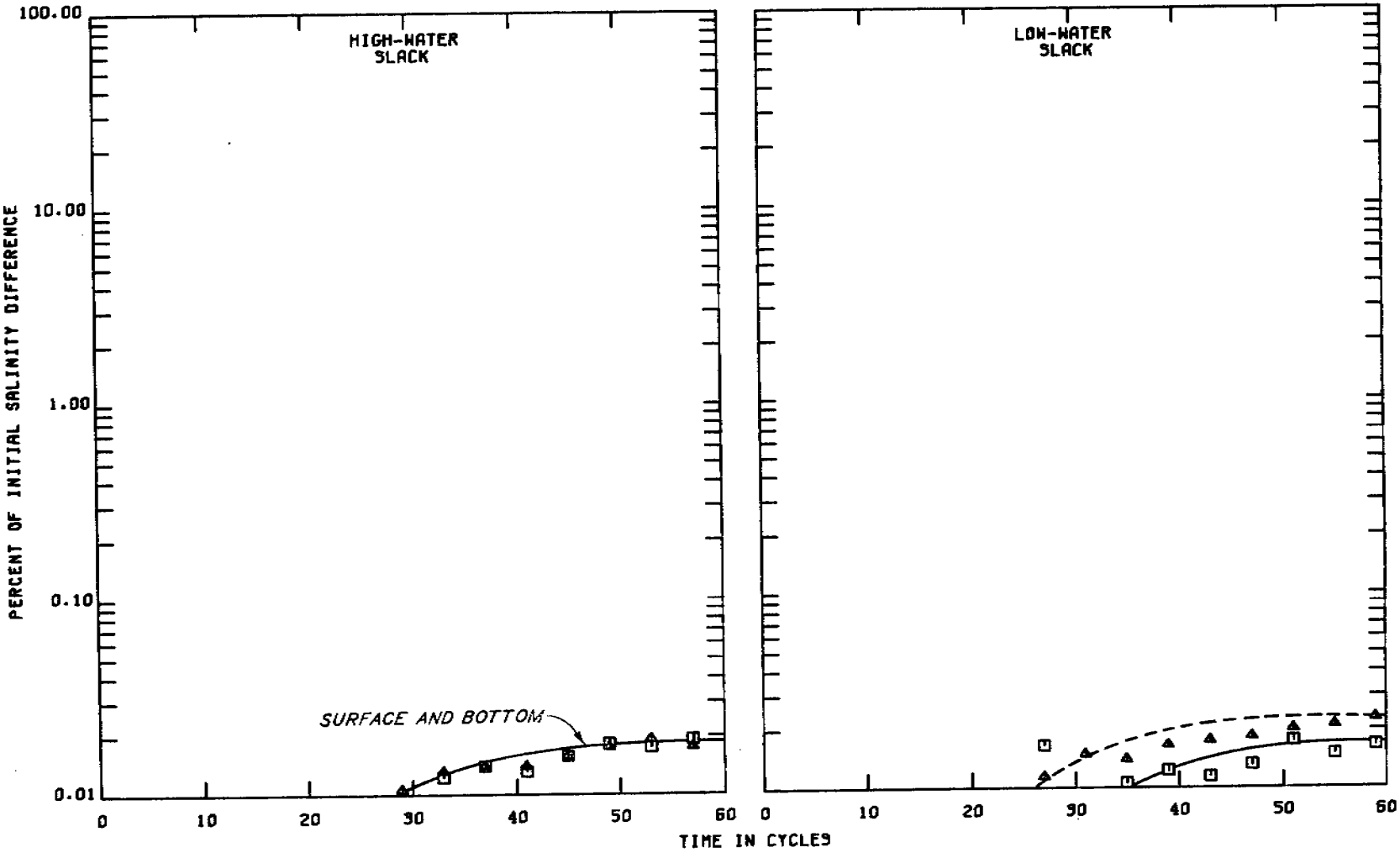
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U3



TEST CONDITIONS	
FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ — — — BOTTOM

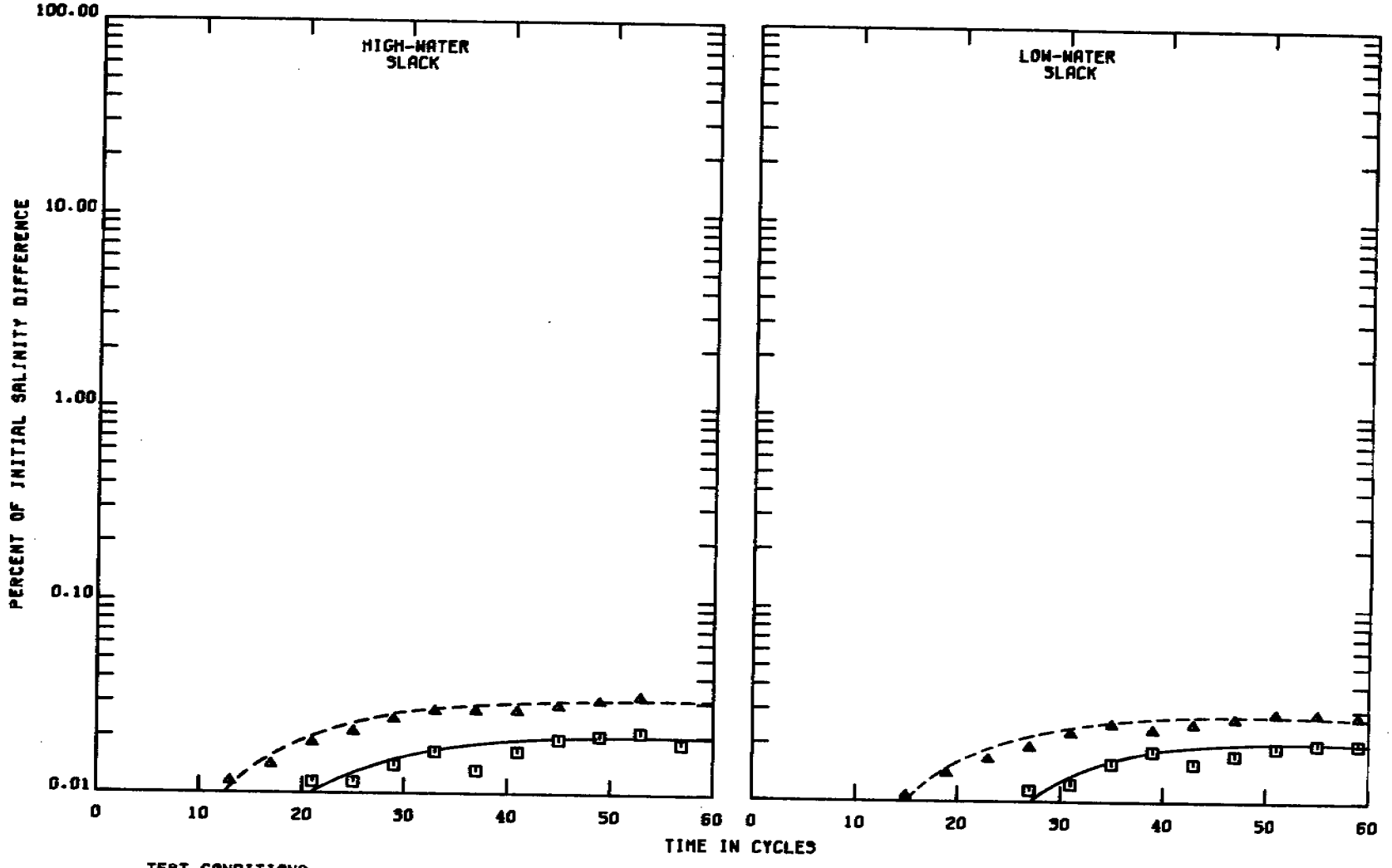
DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U4

PLATE 115



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

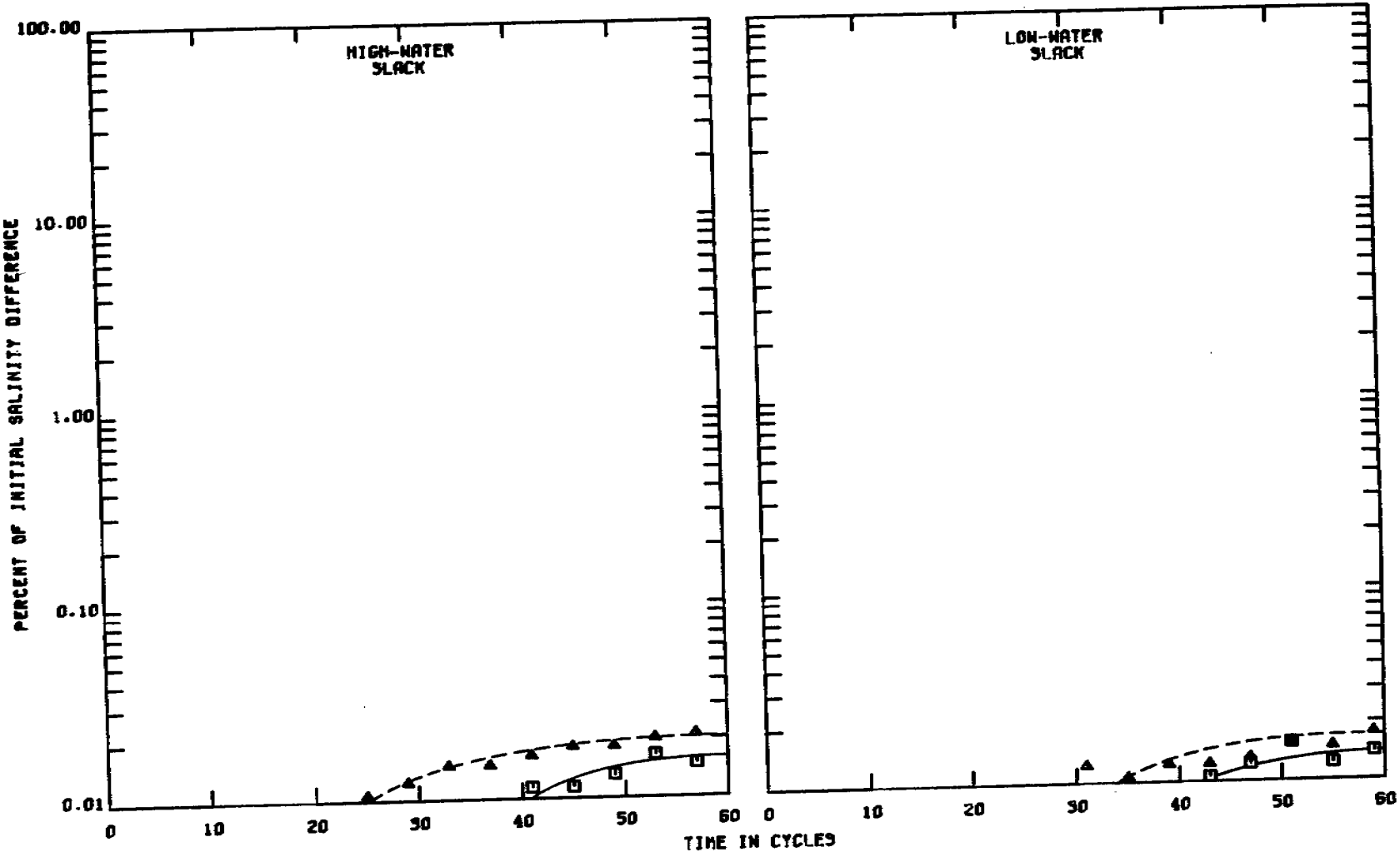
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U5



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

▣ ——— SURFACE

▲ – – – BOTTOM

DELAWARE RIVER MODEL

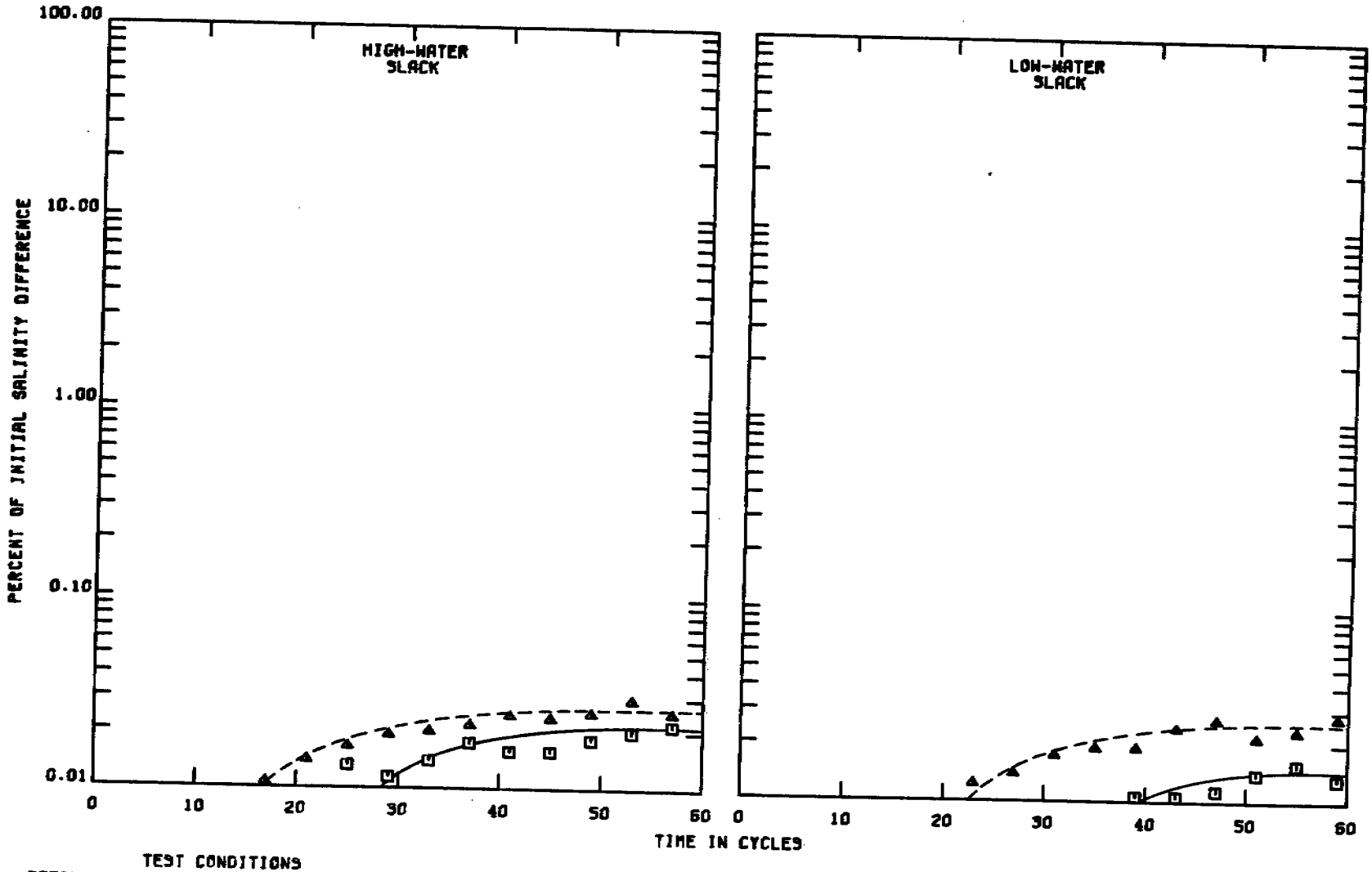
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U6

PLATE 117

PLATE 118



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

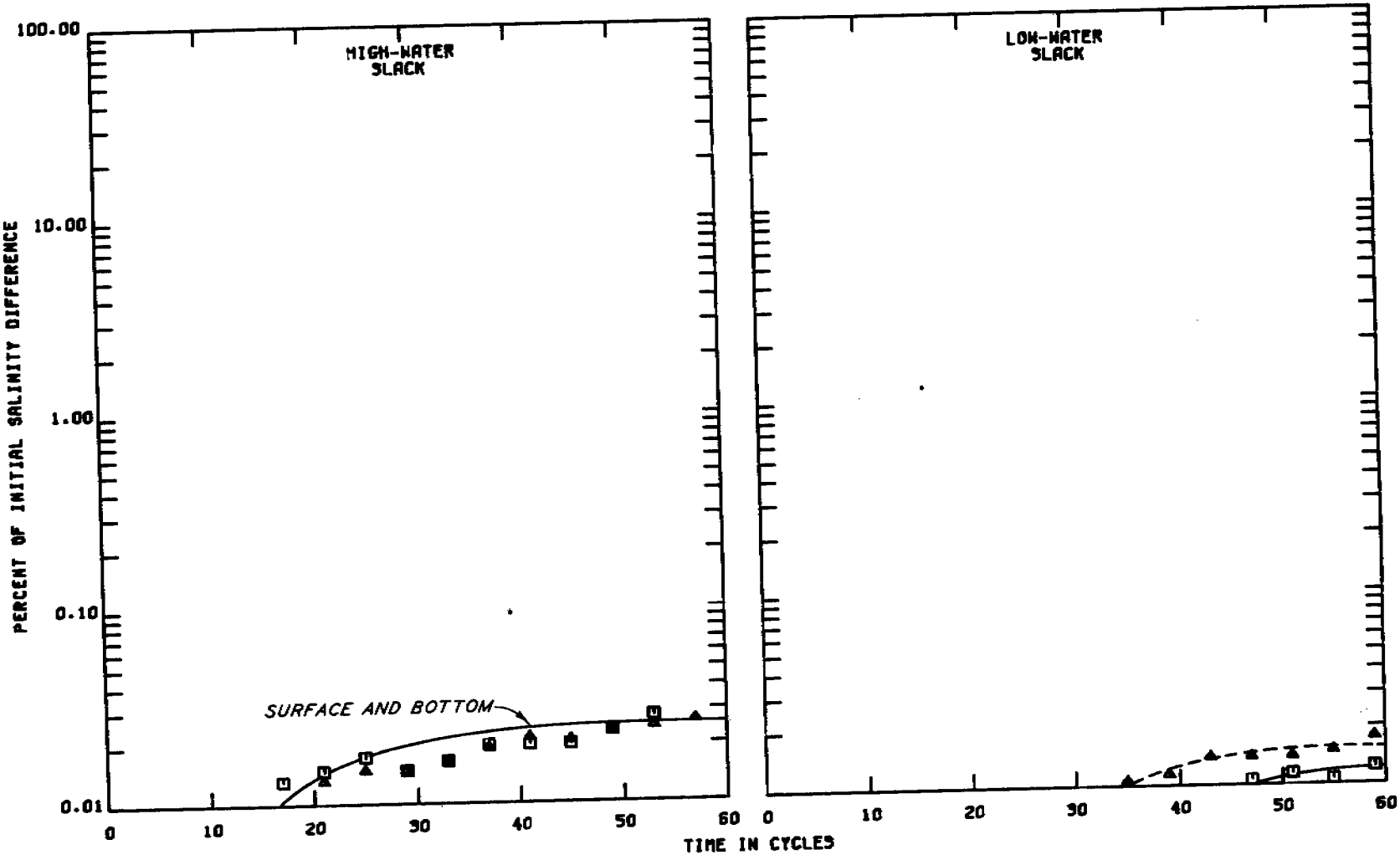
▲ - - - BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U7



TEST CONDITIONS

FRESH-WATER DISCHARGE	6342 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ - - - BOTTOM

DELAWARE RIVER MODEL

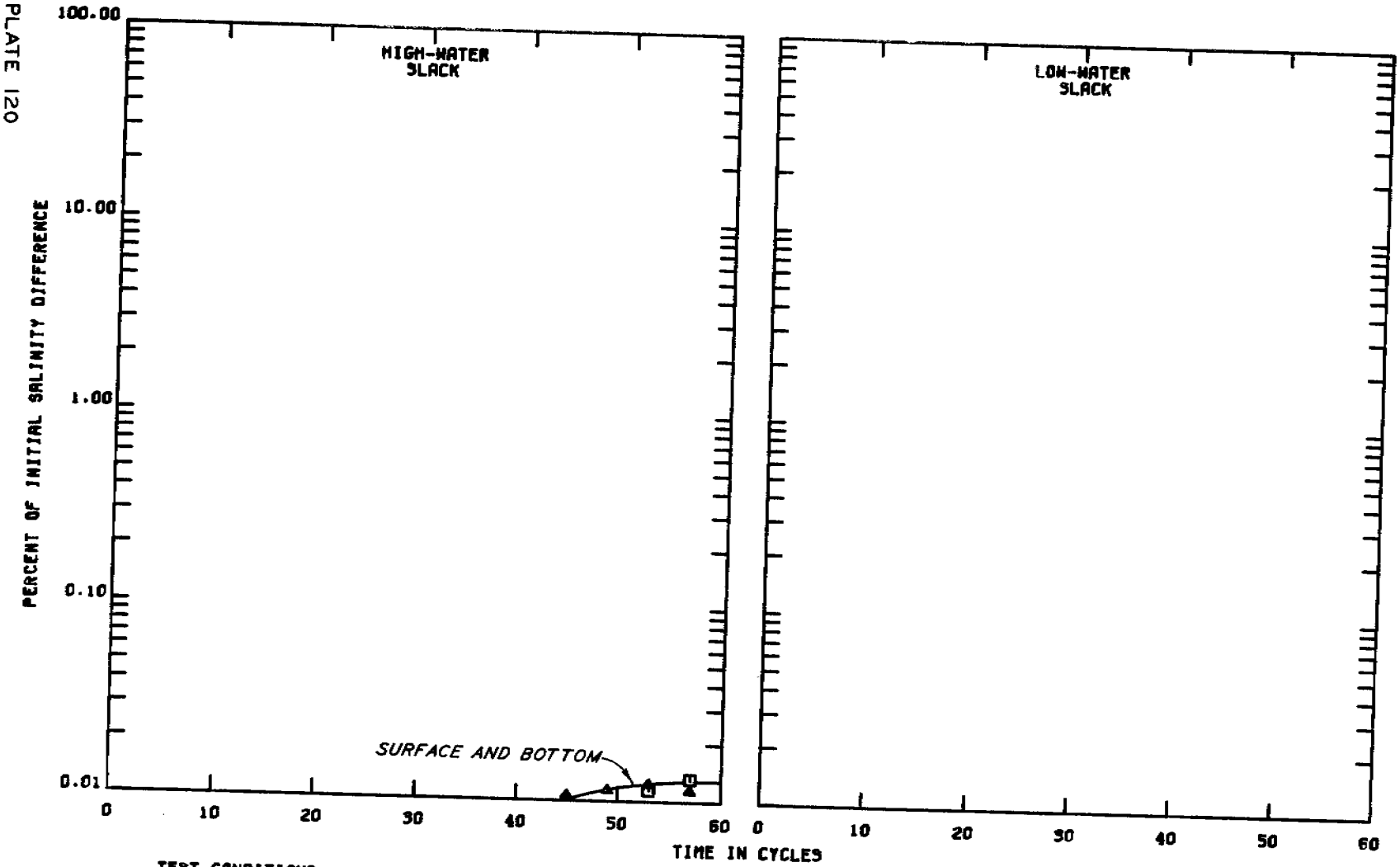
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U8

PLATE 119

PLATE 120



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

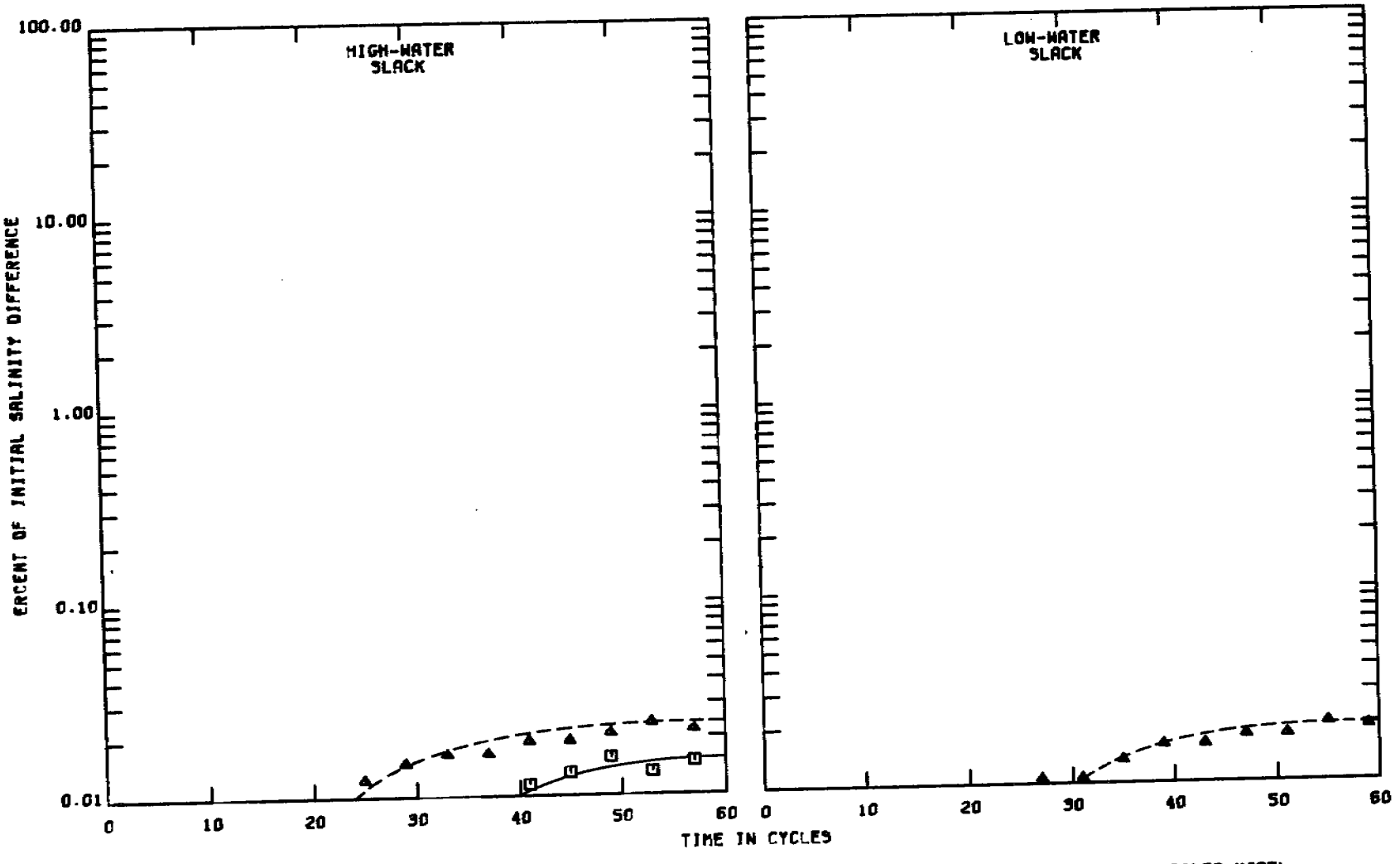
▲ - - - BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U9



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

△ - - - BOTTOM

DELAWARE RIVER MODEL

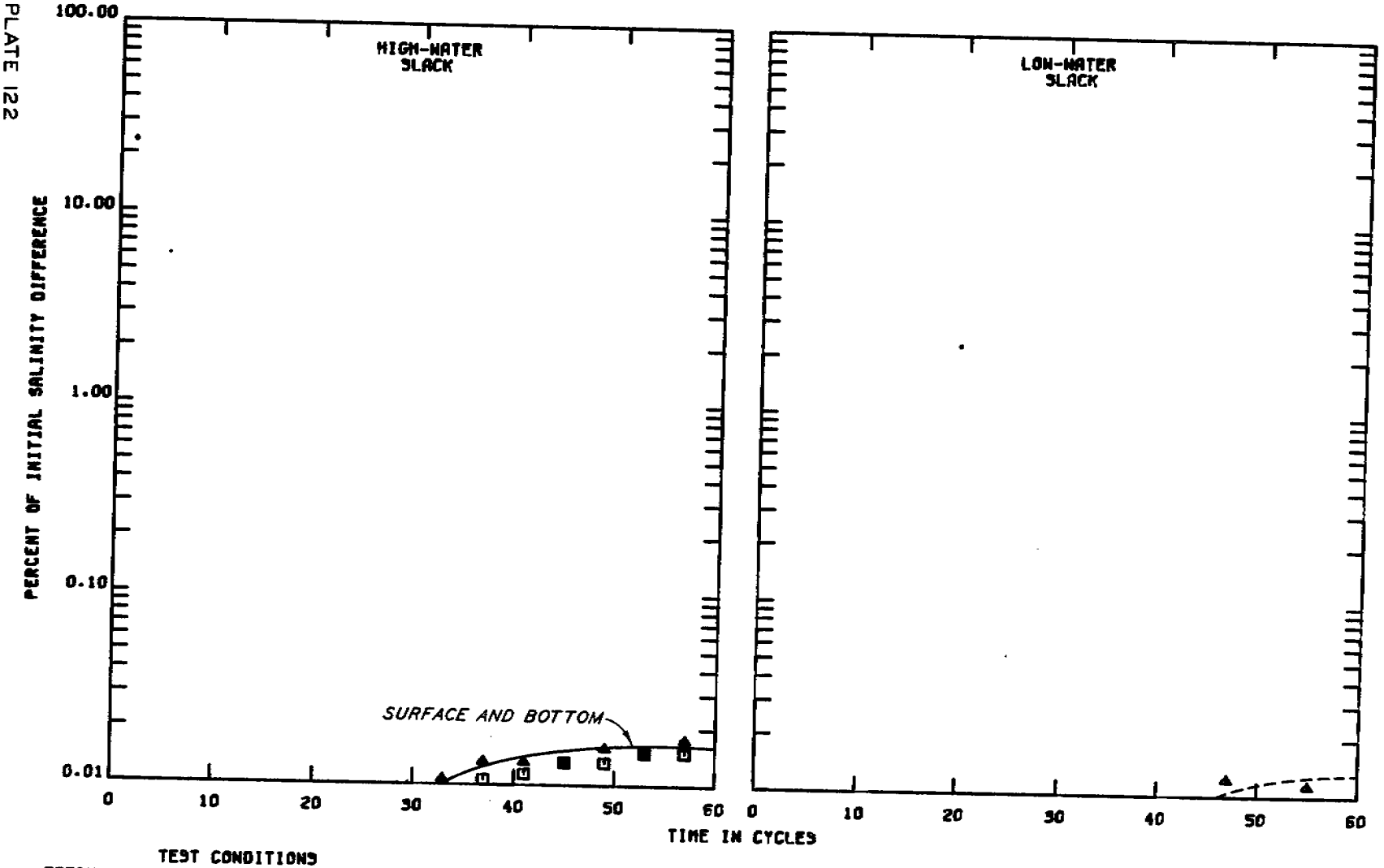
SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U10

PLATE 121

PLATE 122



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE.	21.2 MGD

LEGEND

SURFACE

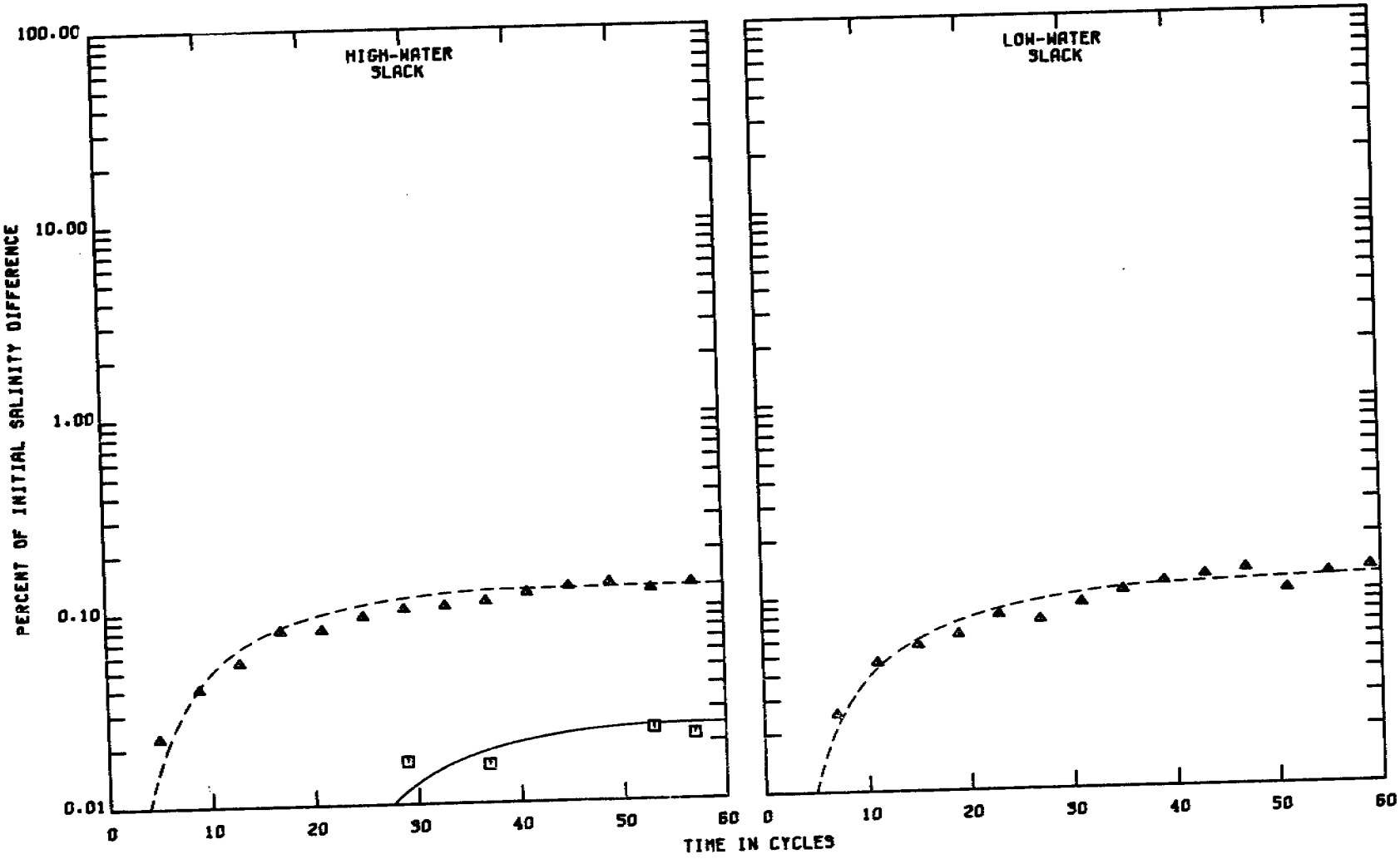
BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION U11



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

△ – – – BOTTOM

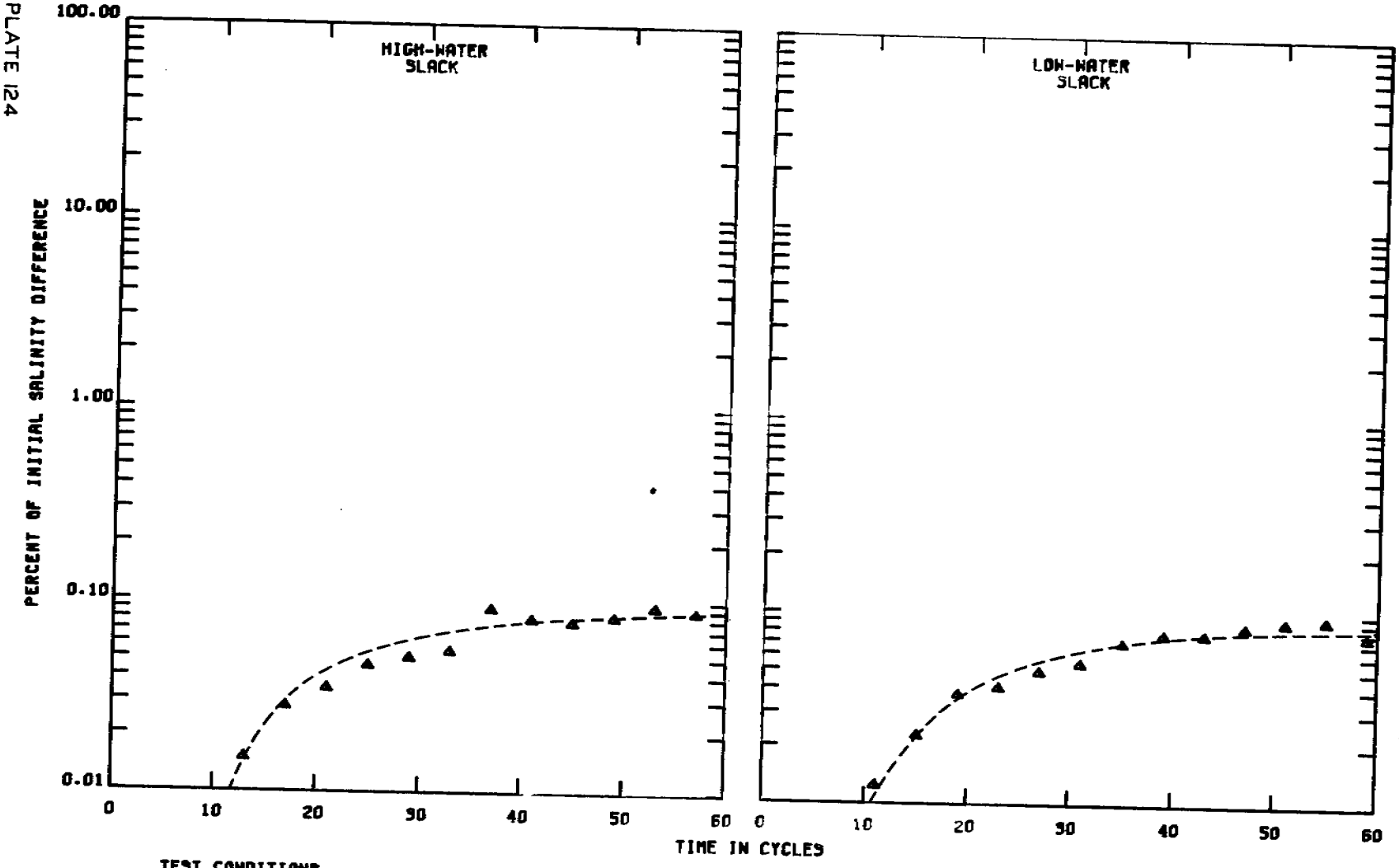
DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION CR1

PLATE 123



TEST CONDITIONS

FRESH-WATER DISCHARGE	6542 CFS
BASE SALINITY AT DIFFUSER	21.0 PPT
EFFLUENT SALINITY	32.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

⊡ ——— SURFACE

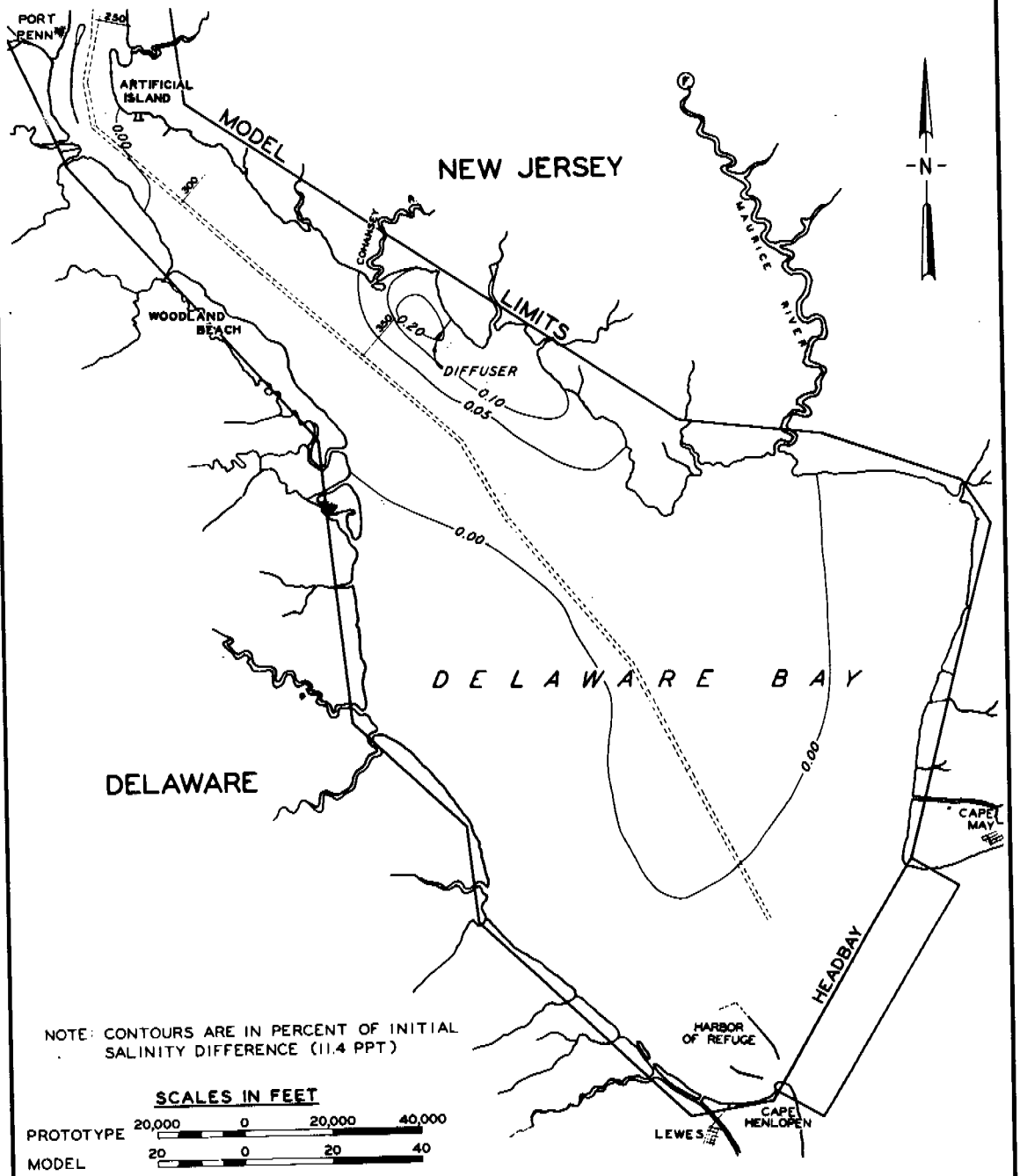
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-LOW FLOW PERIOD

STATION CR 2



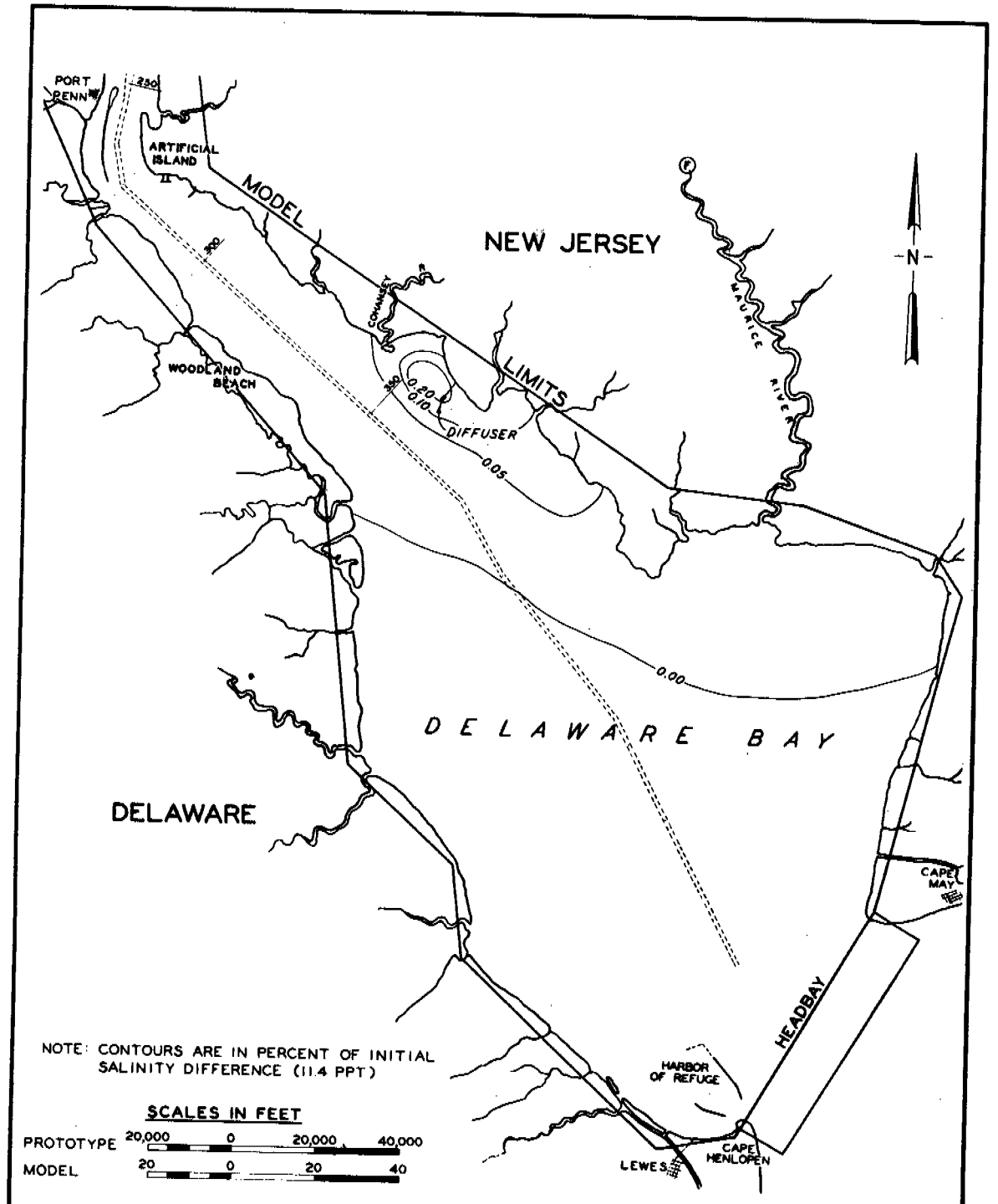
DELAWARE RIVER MODEL

EFFLUENT DISPERSION PATTERNS

LOCAL HIGH-WATER SLACK
SURFACE DEPTH - CYCLE 60

LOW-FLOW PERIOD

PLATE 125



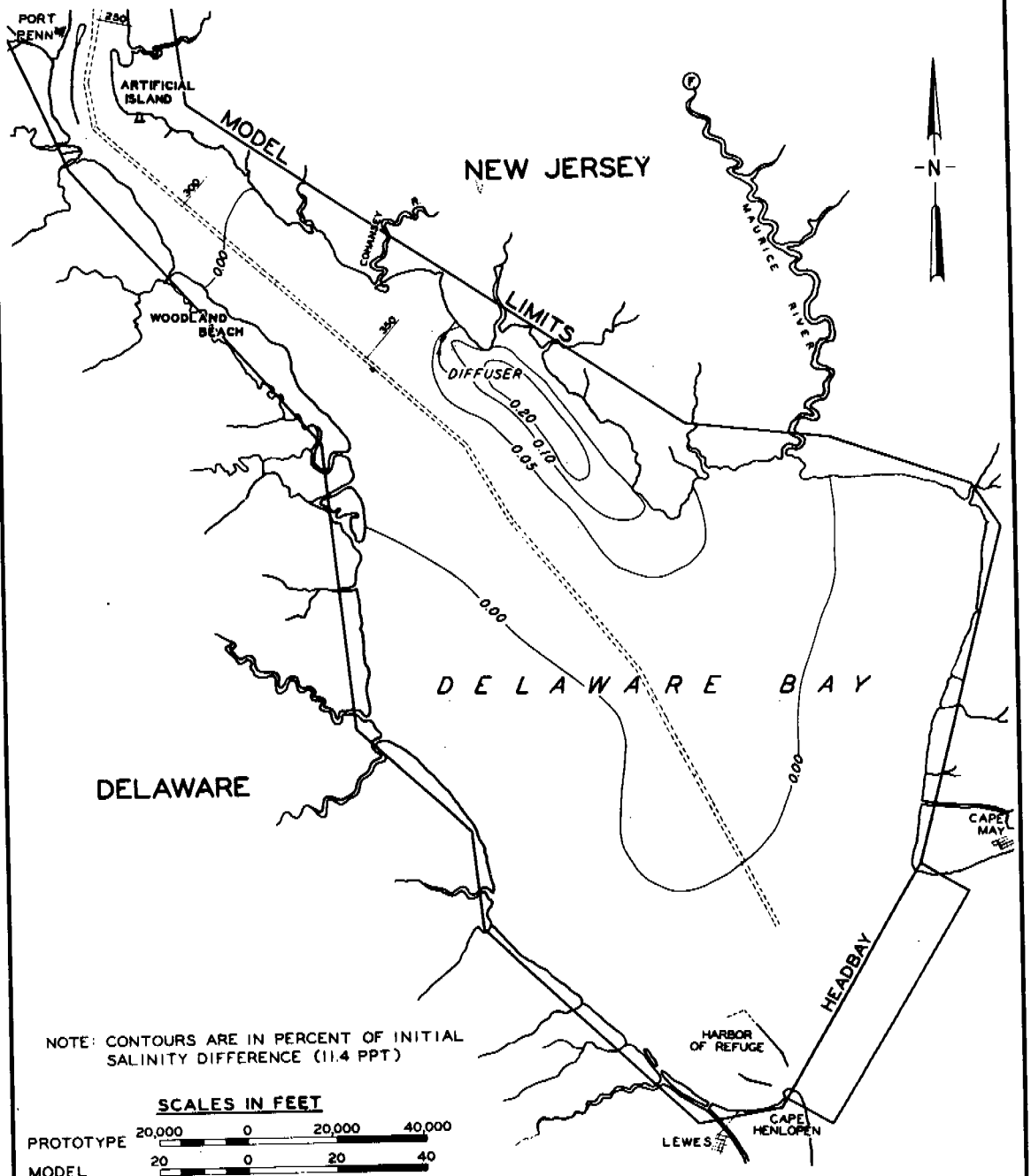
DELAWARE RIVER MODEL

EFFLUENT DISPERSION PATTERNS

LOCAL HIGH-WATER SLACK
BOTTOM DEPTH - CYCLE 60

LOW-FLOW PERIOD

PLATE 126



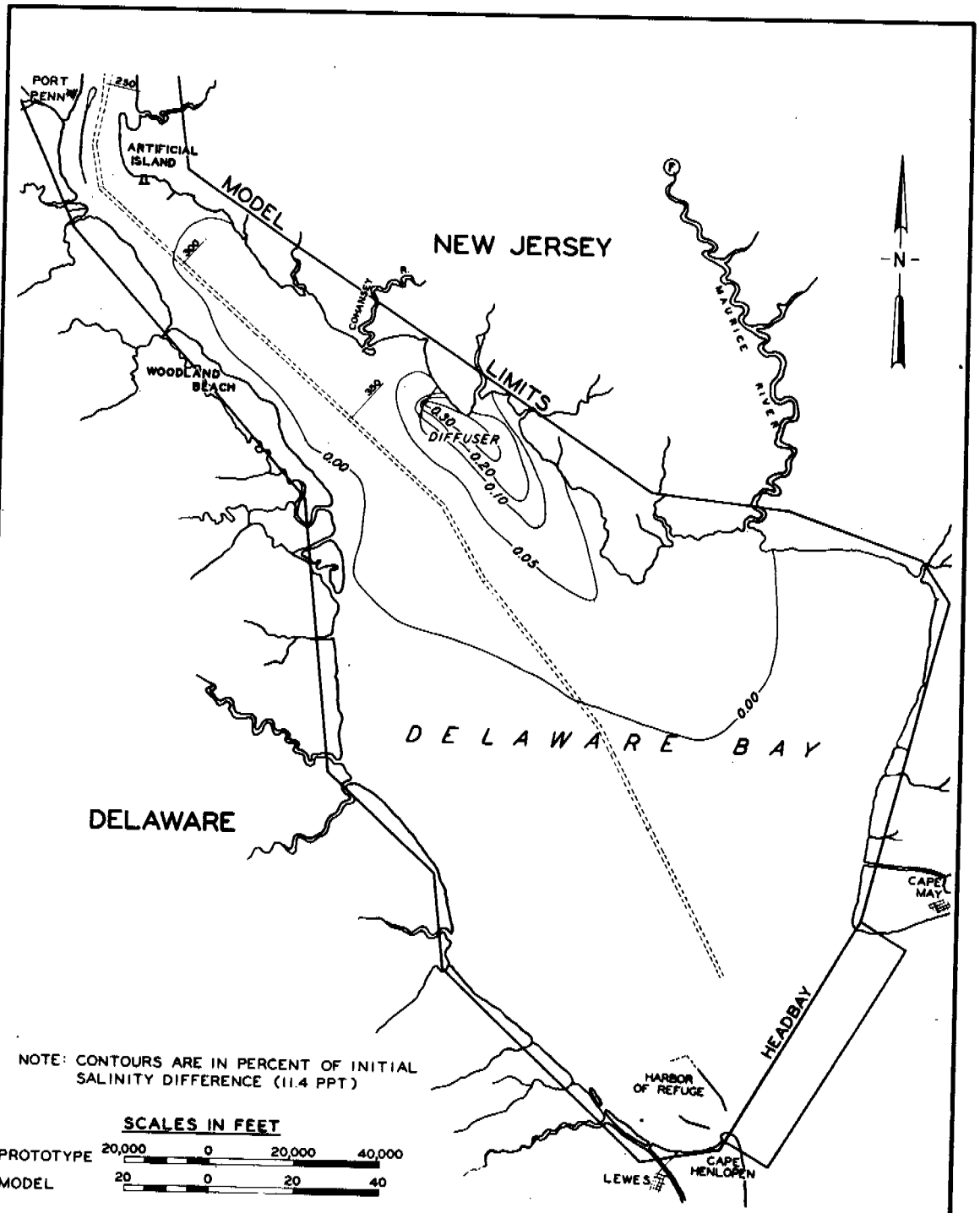
DELAWARE RIVER MODEL

EFFLUENT DISPERSION PATTERNS

LOCAL LOW-WATER SLACK
SURFACE DEPTH - CYCLE 60

LOW-FLOW PERIOD

PLATE 127



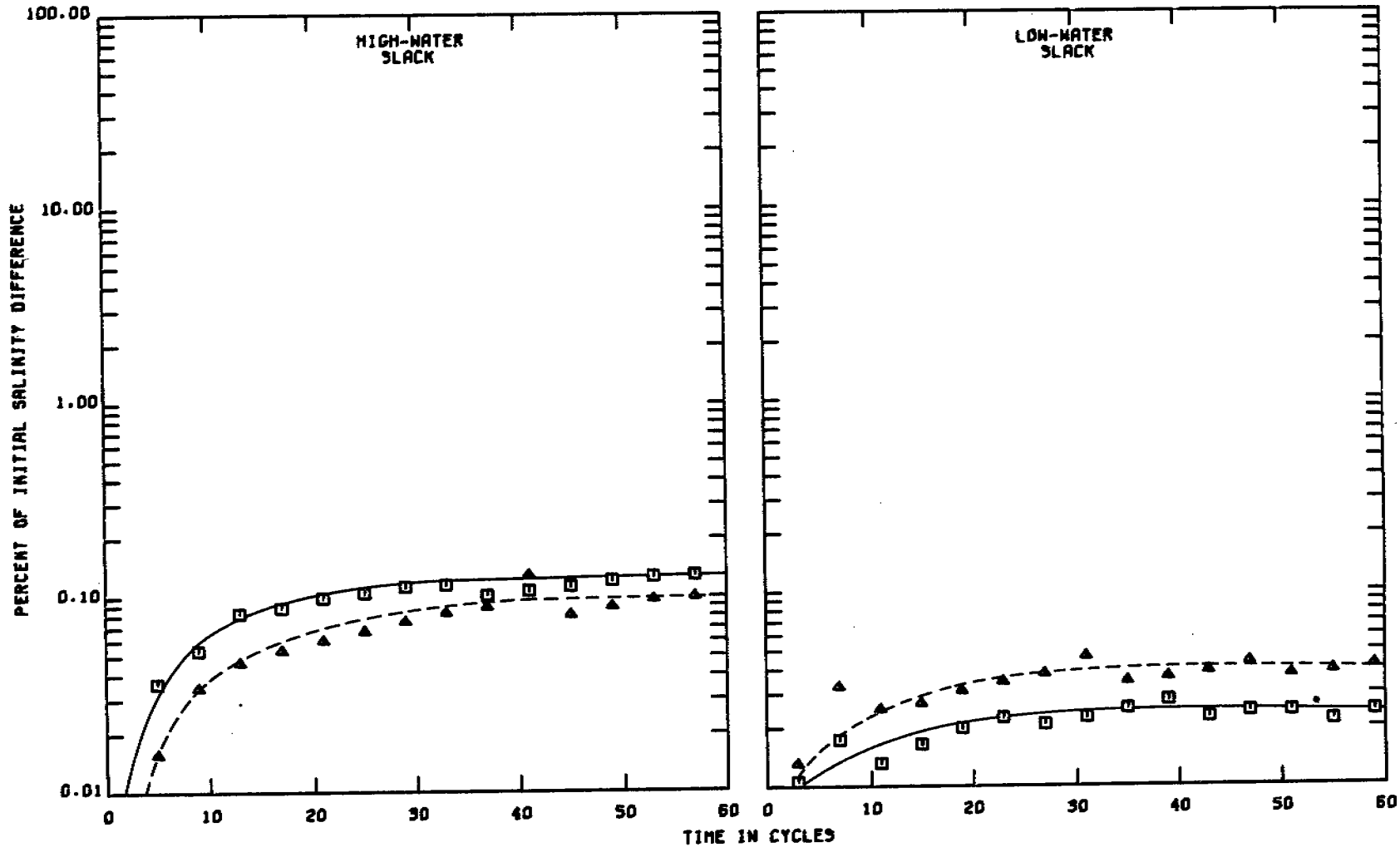
DELAWARE RIVER MODEL

EFFLUENT DISPERSION PATTERNS

LOCAL LOW-WATER SLACK
BOTTOM DEPTH - CYCLE 60

LOW-FLOW PERIOD

PLATE 128



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

DELAWARE RIVER MODEL

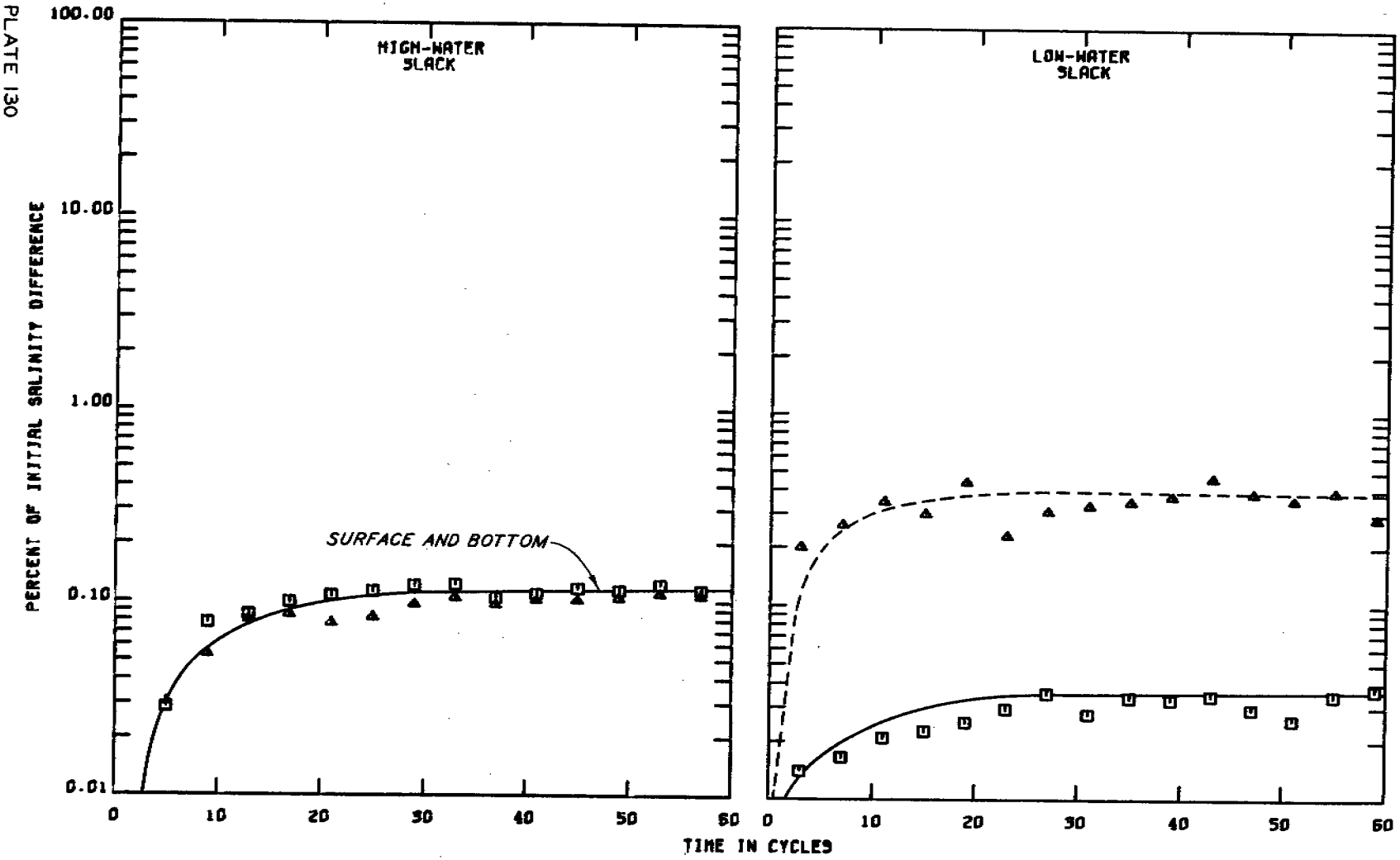
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D1

PLATE 129

PLATE 130



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

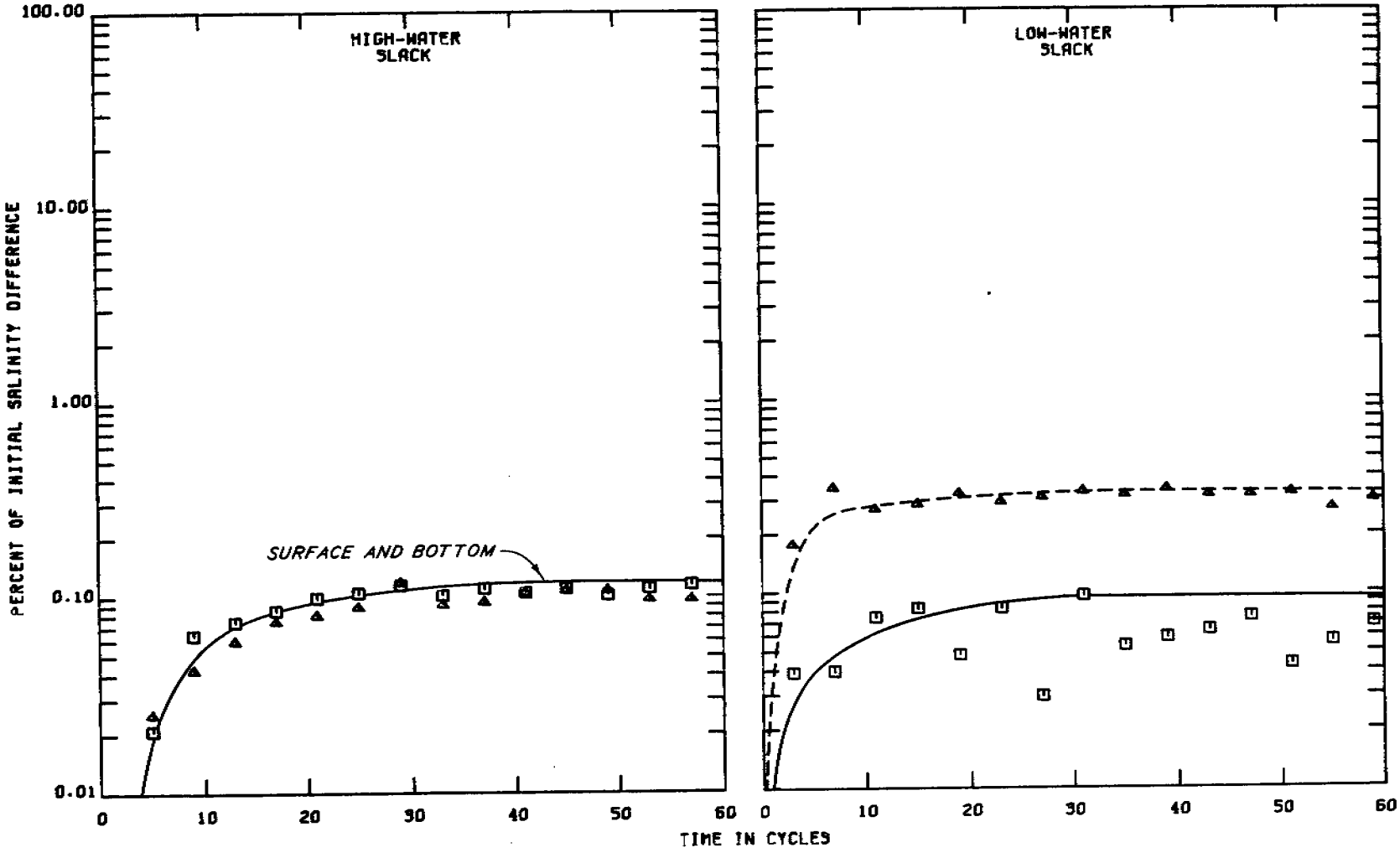
BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D2



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

△ - - - BOTTOM

DELAWARE RIVER MODEL

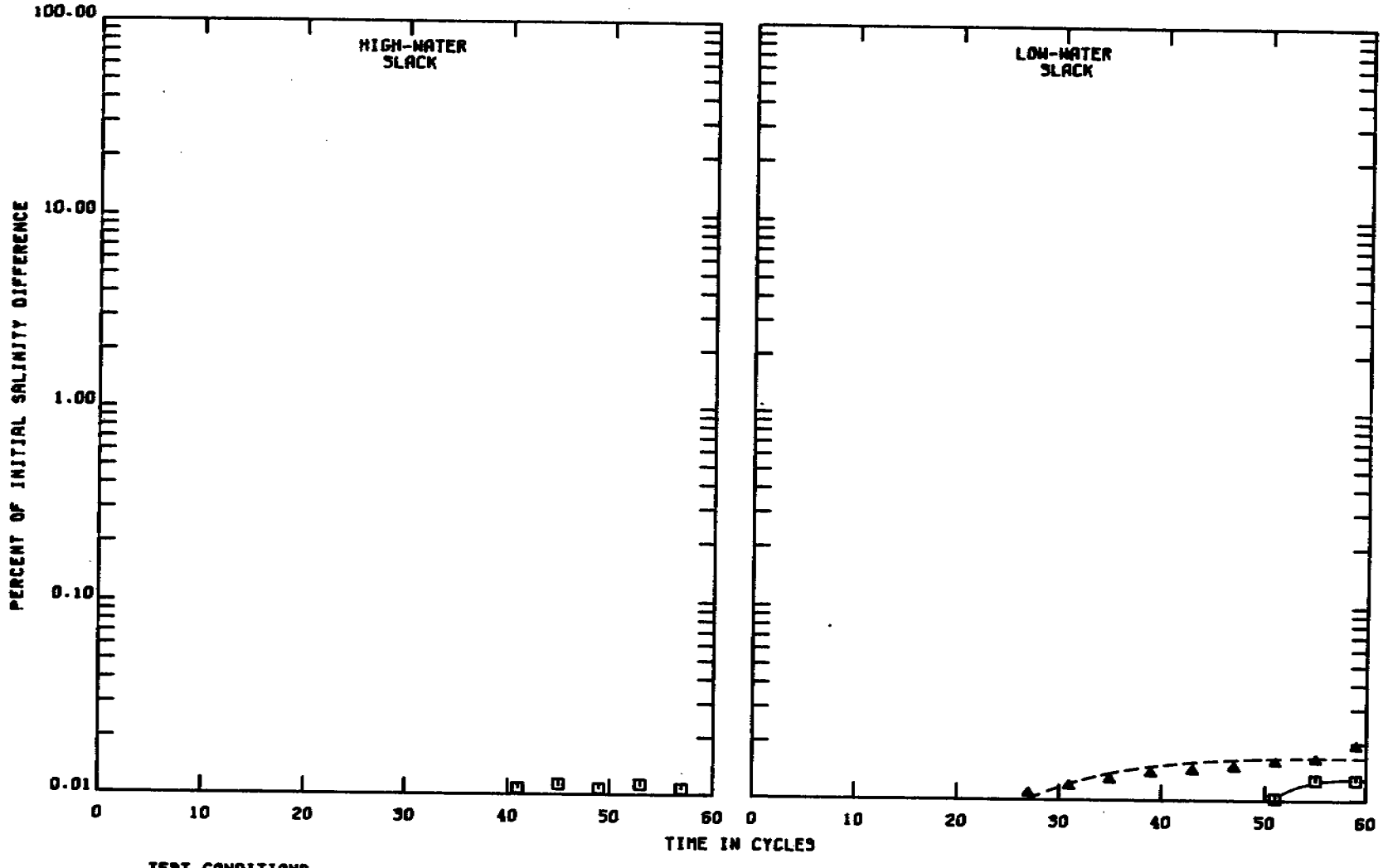
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D3

PLATE 131

PLATE 132



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

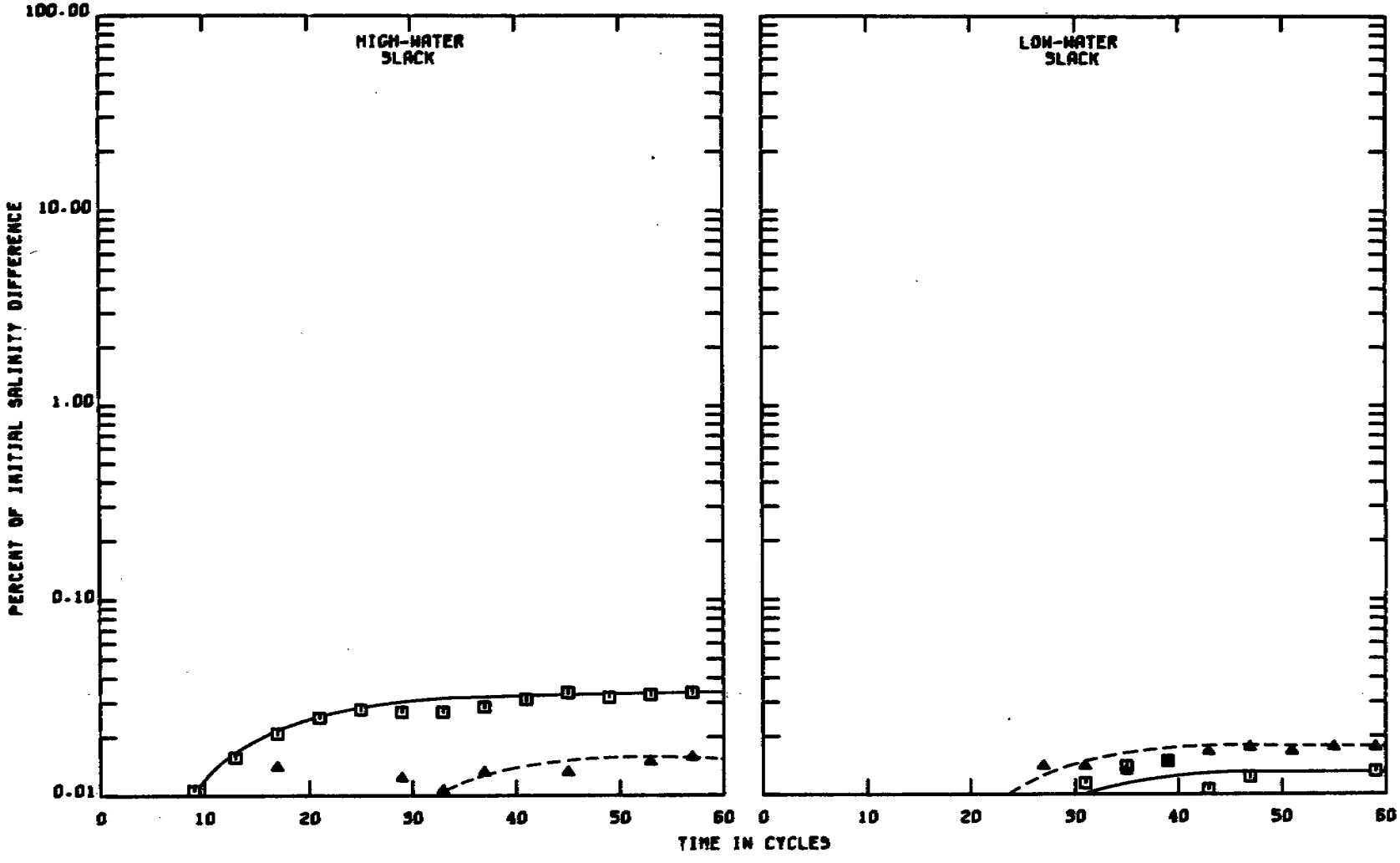
BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D5



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

DELAWARE RIVER MODEL

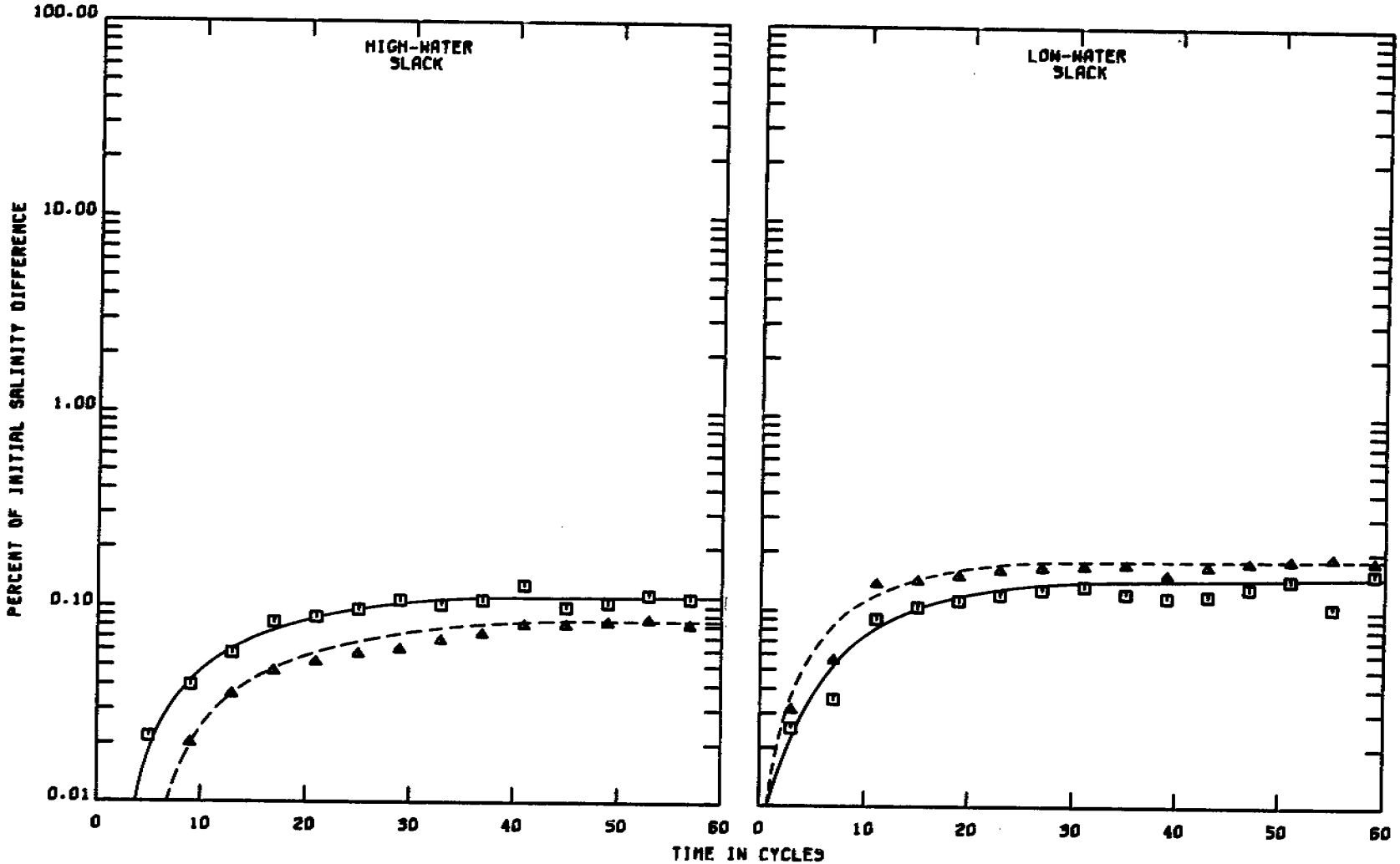
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D6

PLATE 133

PLATE 134



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

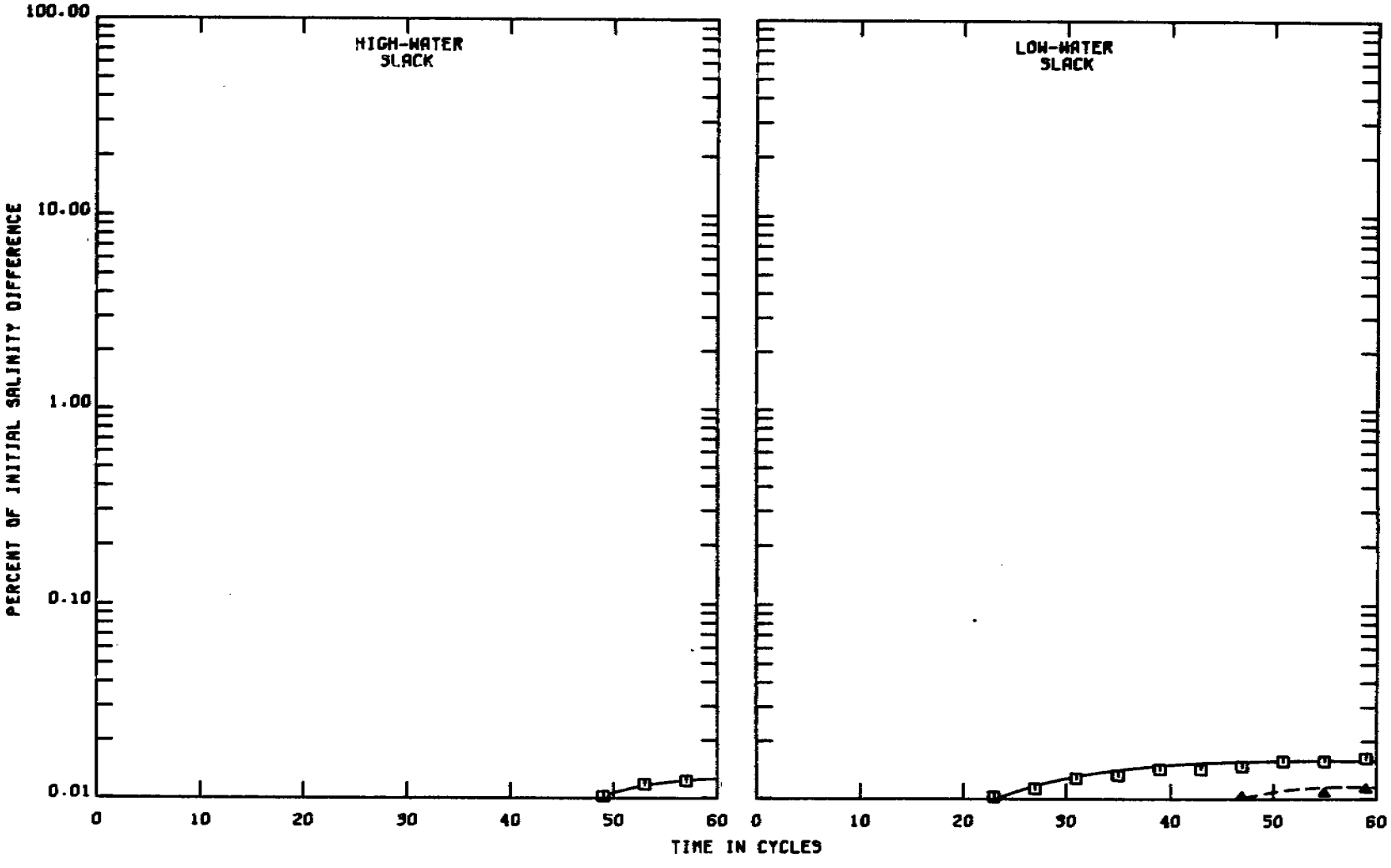
▲ - - - BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D7



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

BOTTOM

DELAWARE RIVER MODEL

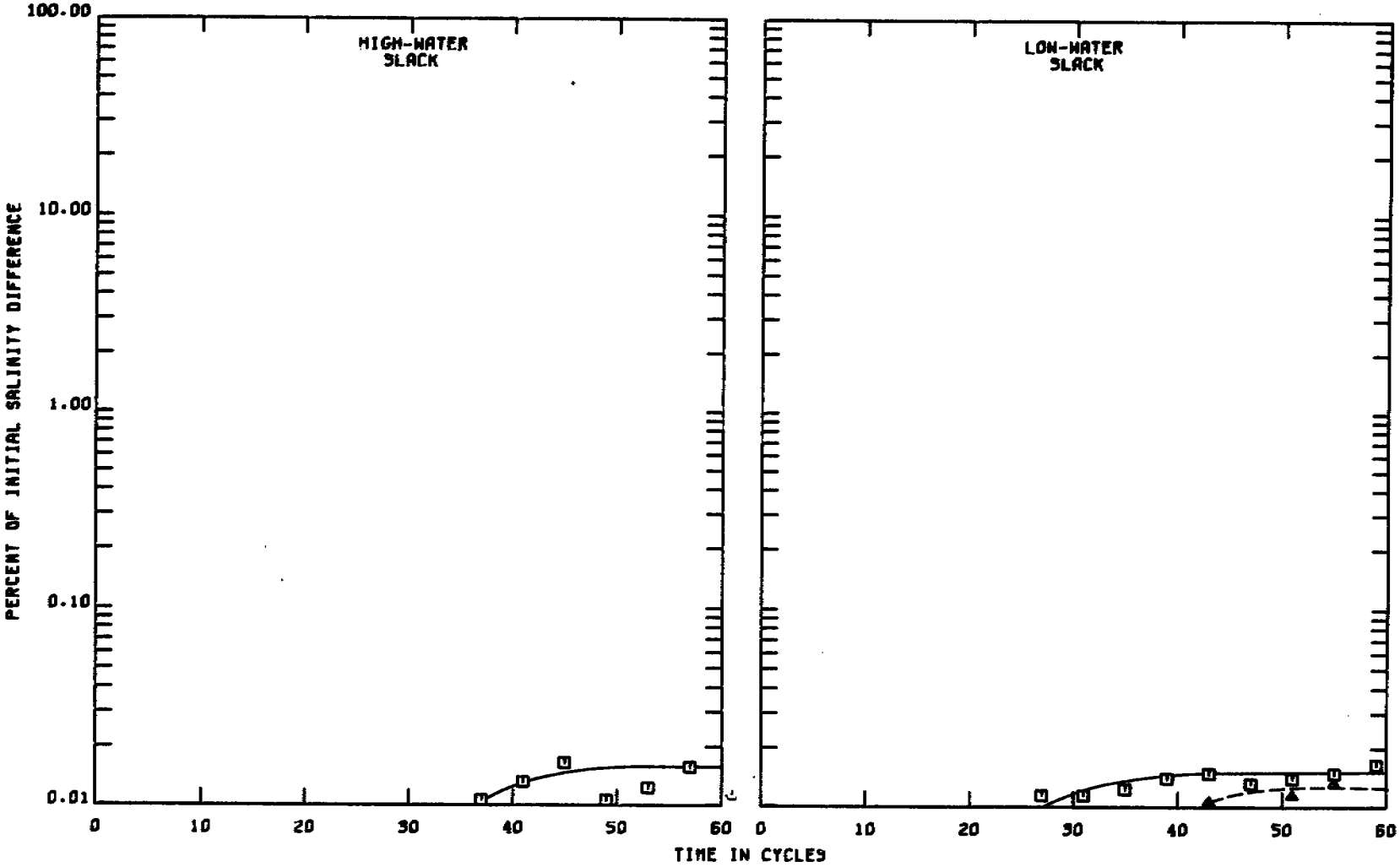
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D9

PLATE 135

PLATE 136



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

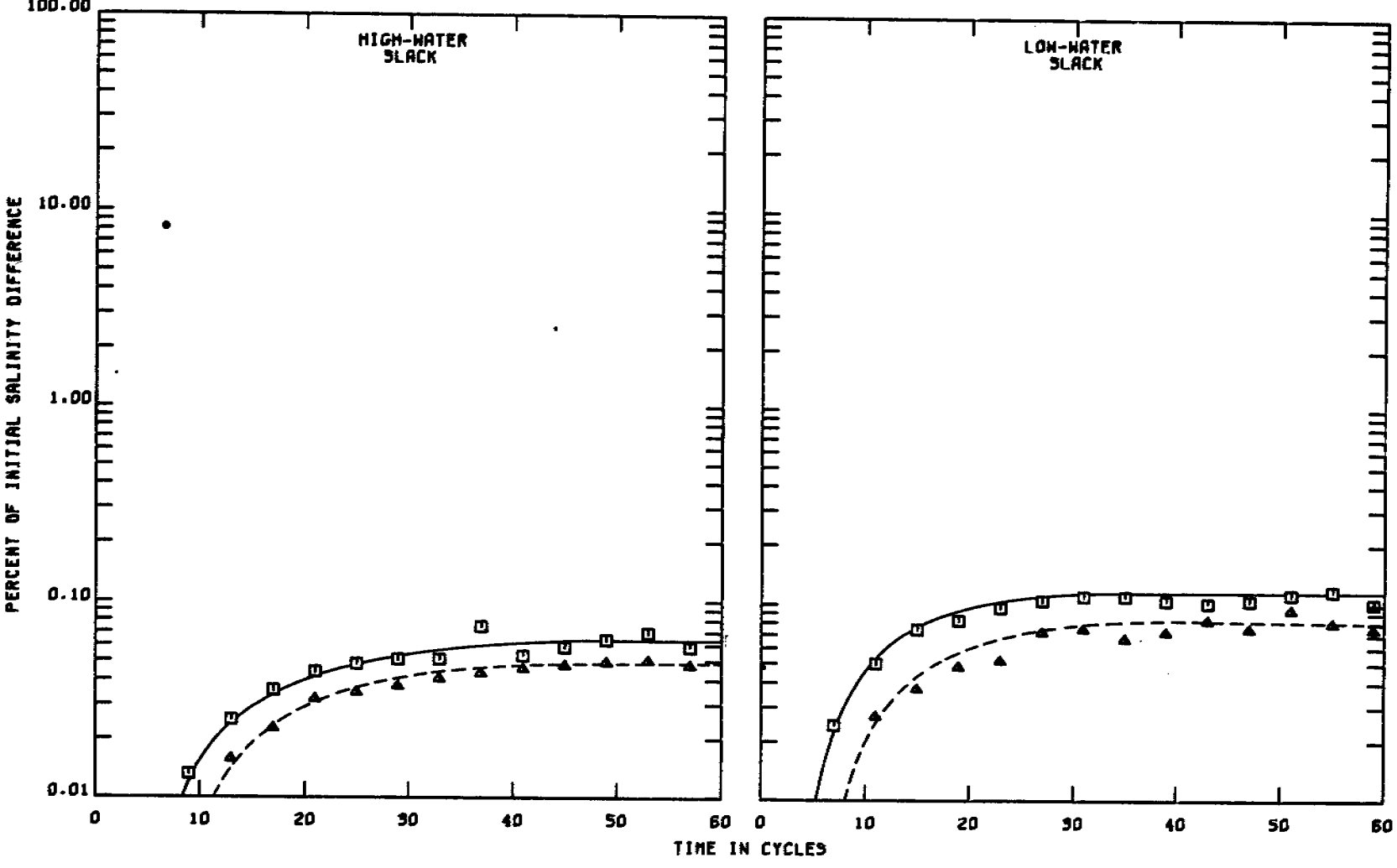
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D10



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

DELAWARE RIVER MODEL

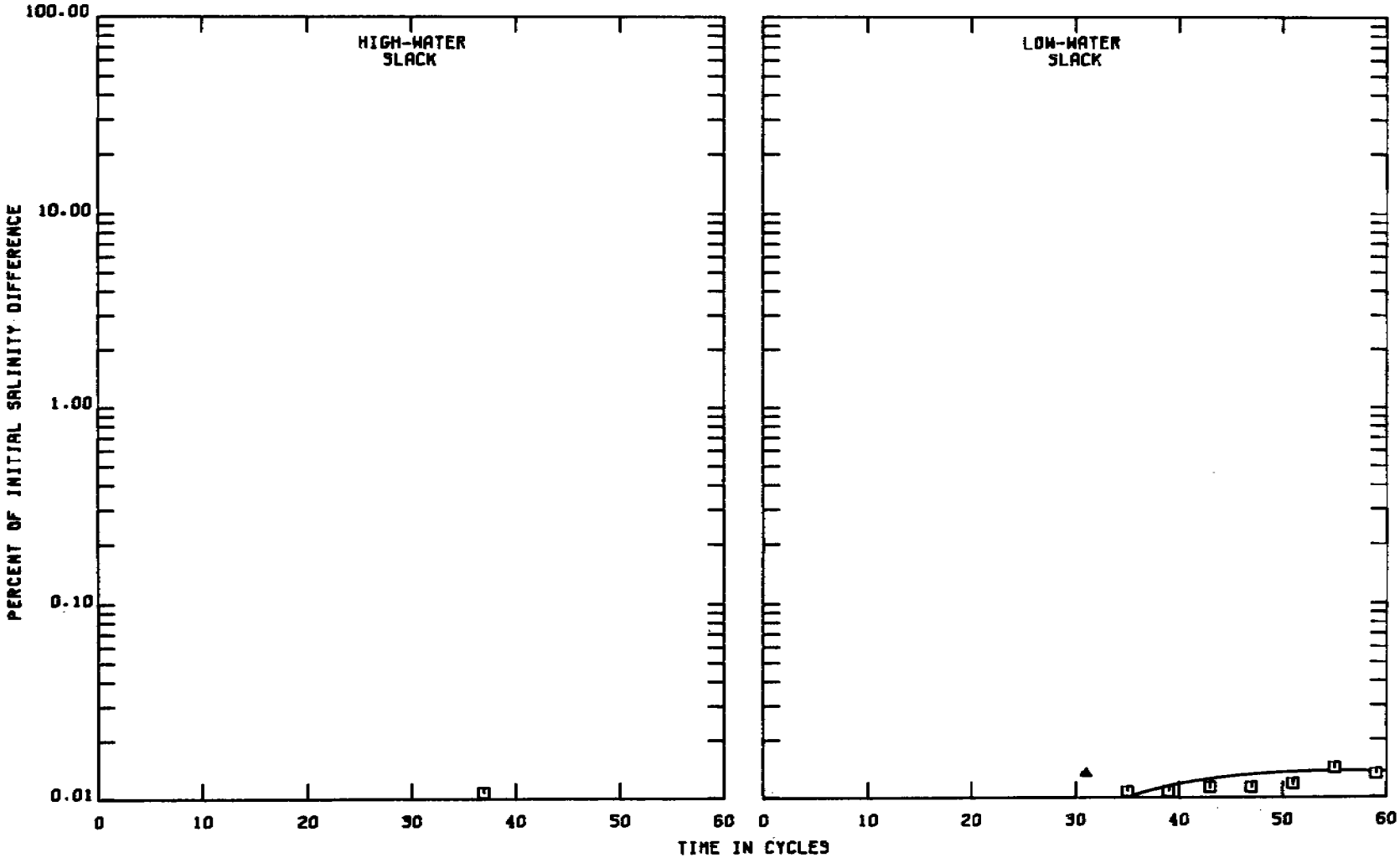
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION DII

PLATE 137

PLATE 138



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

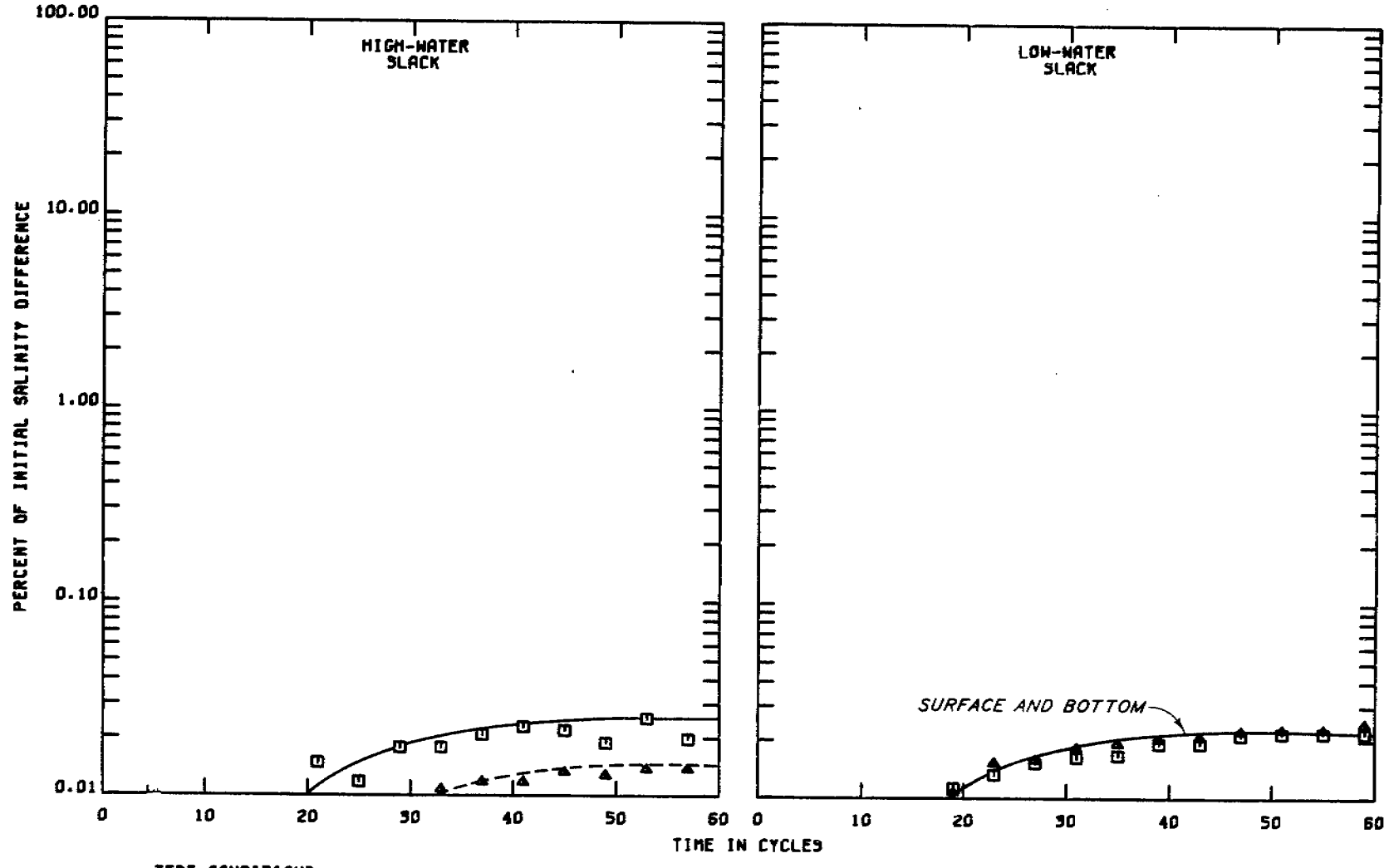
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D13



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

△ - - - BOTTOM

DELAWARE RIVER MODEL

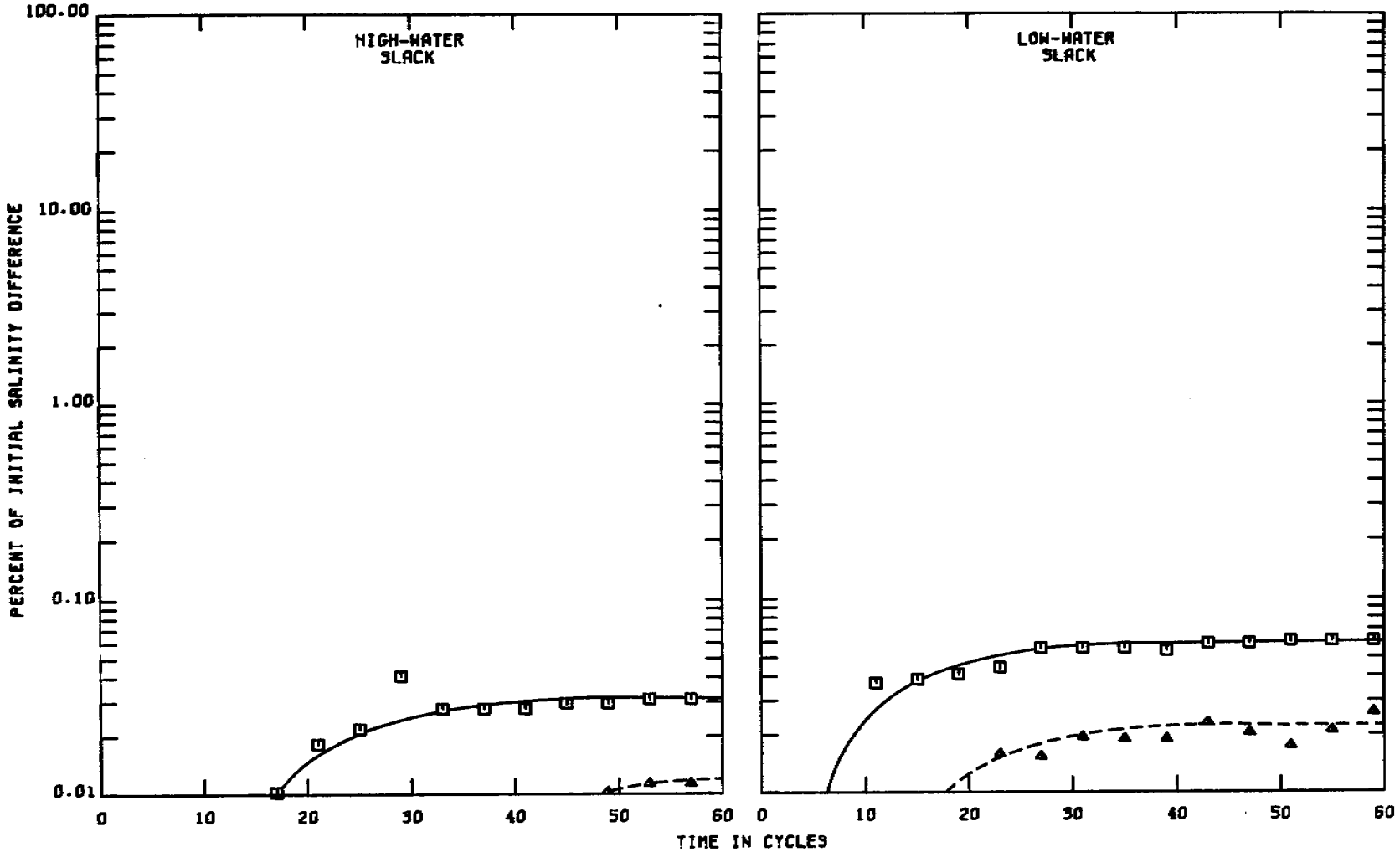
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D14

PLATE 139

PLATE 140



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

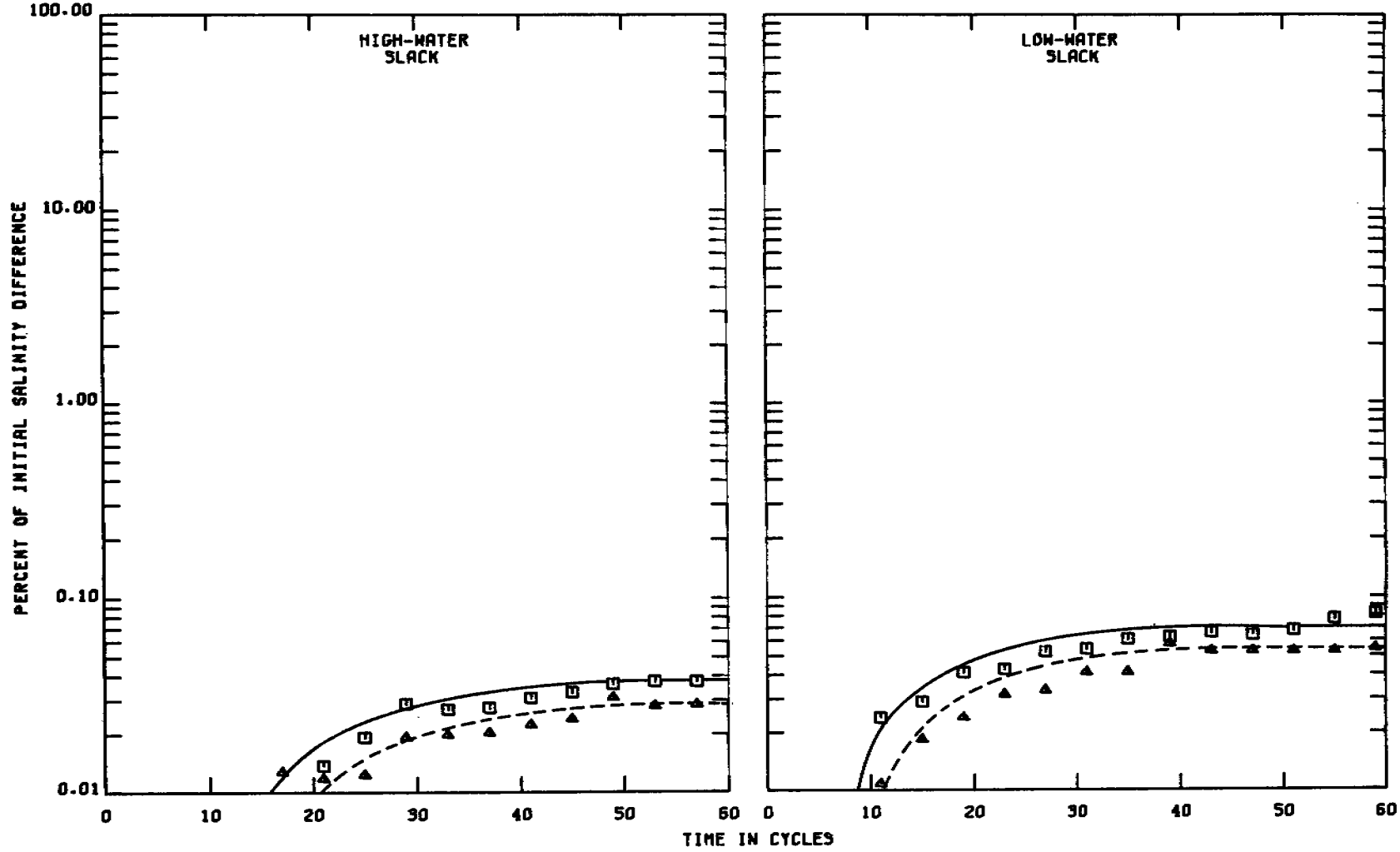
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D15



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ - - - BOTTOM

DELAWARE RIVER MODEL

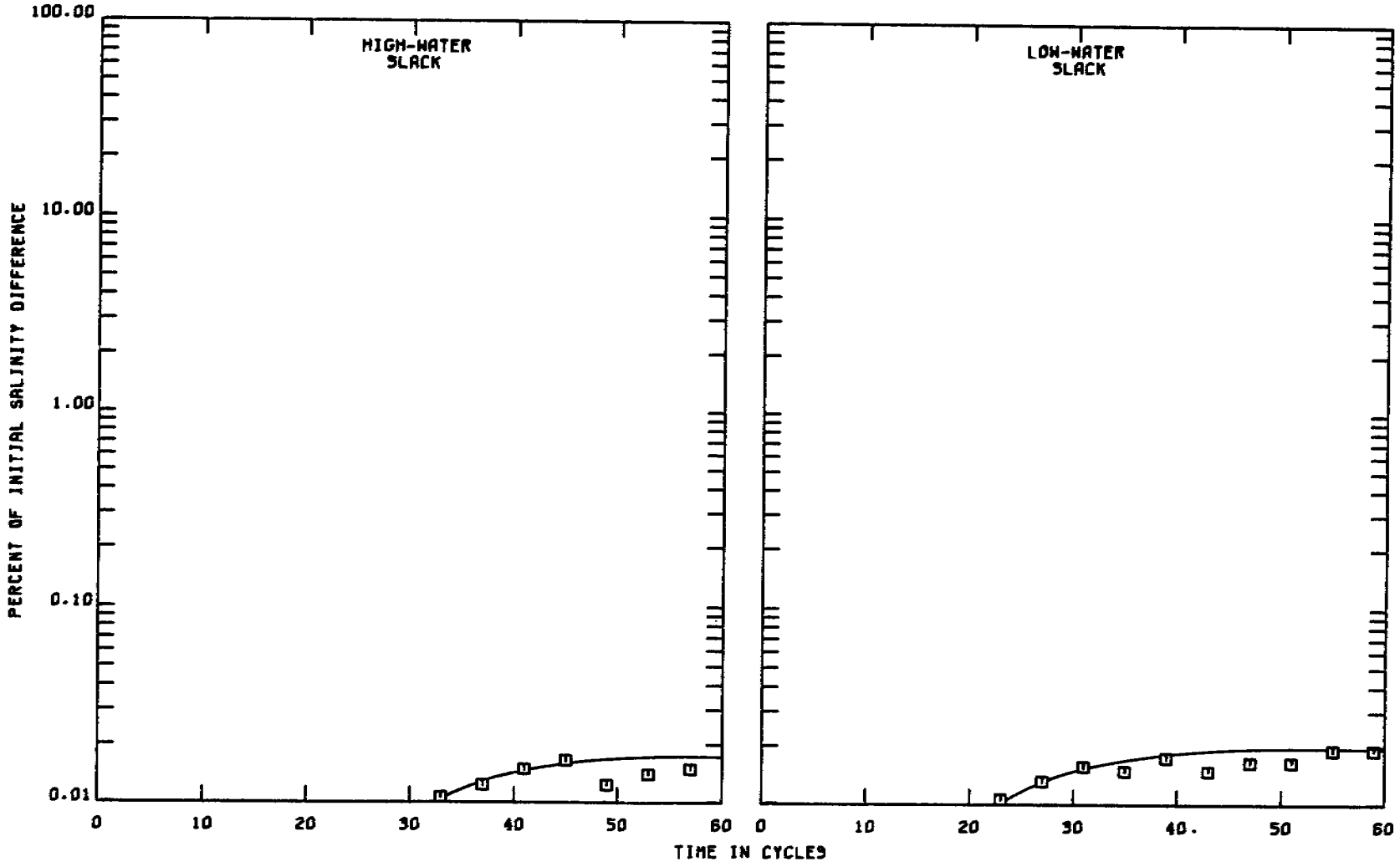
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D16

PLATE 141

PLATE 142



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

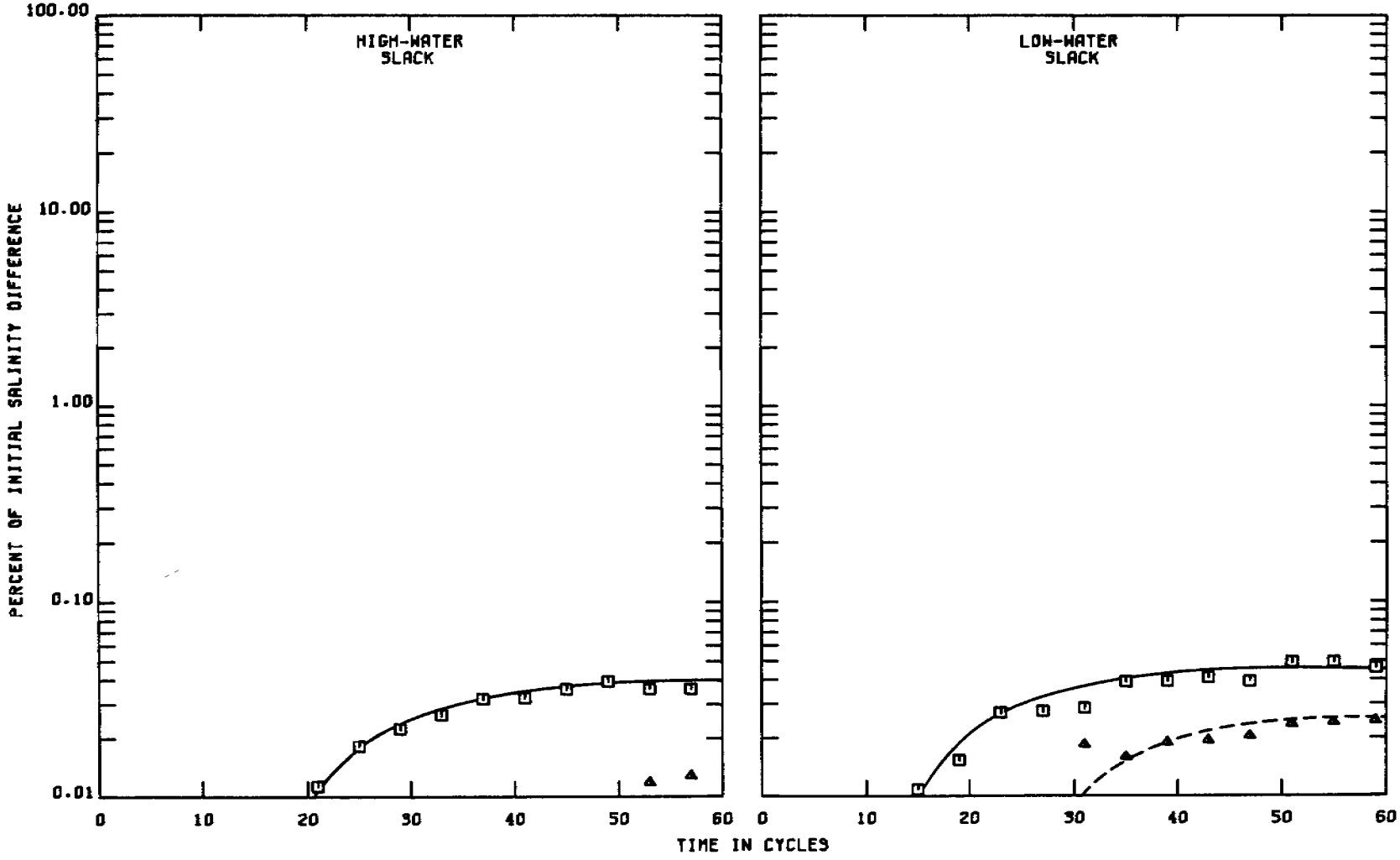
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D19



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ – – – BOTTOM

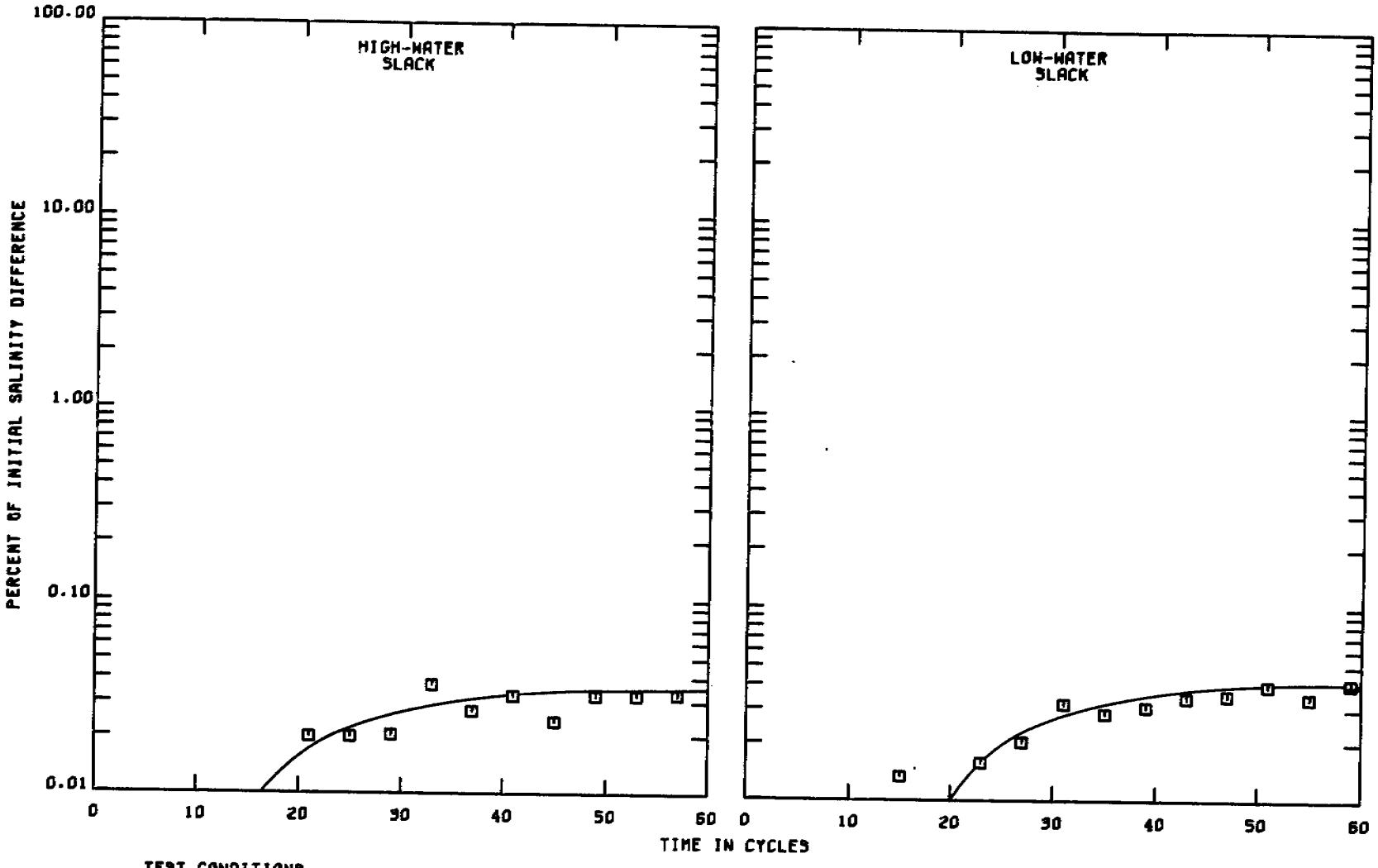
DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D20

PLATE 143



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

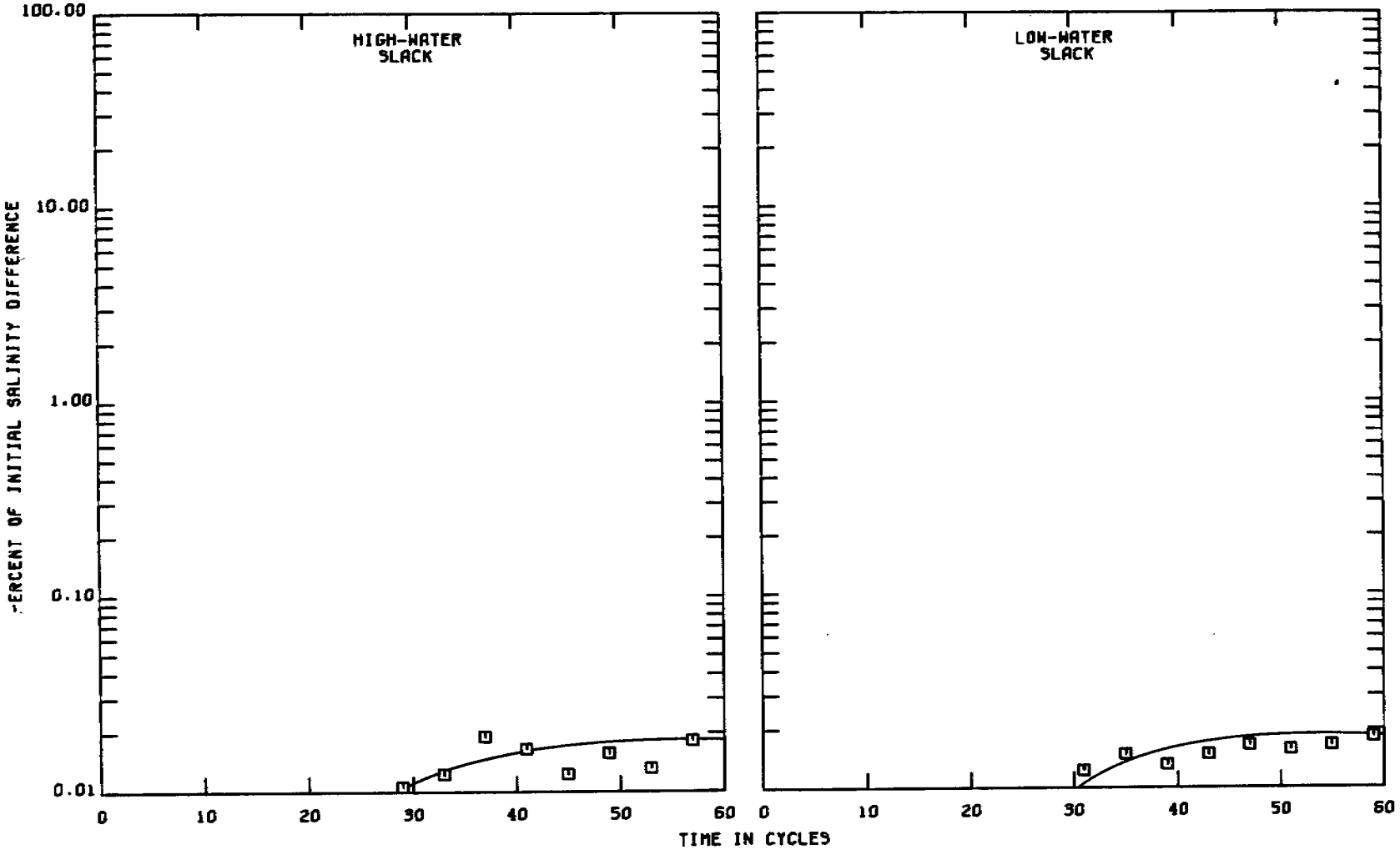
△ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D21



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ — — — BOTTOM

DELAWARE RIVER MODEL

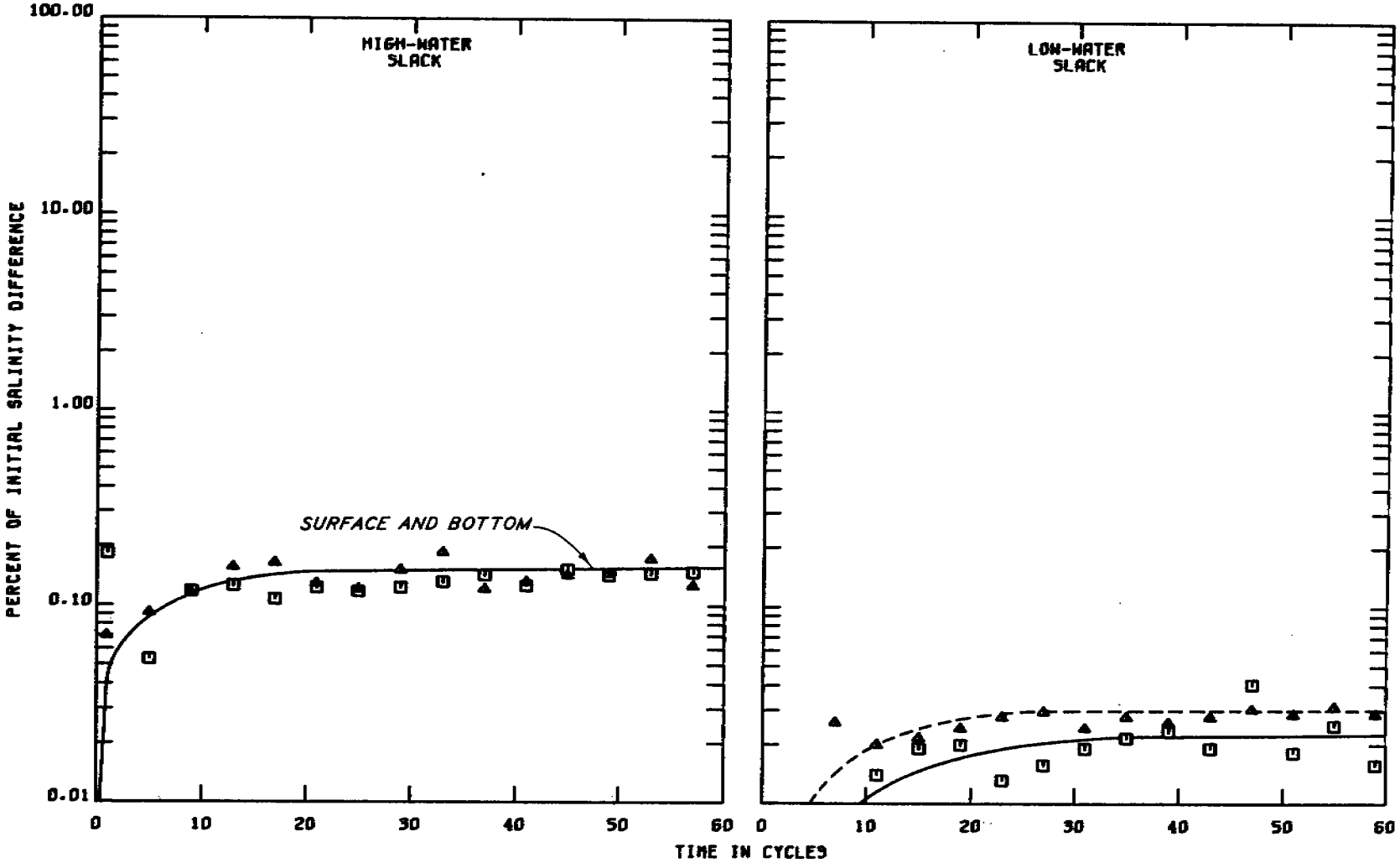
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION D22

PLATE 145

PLATE 146



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

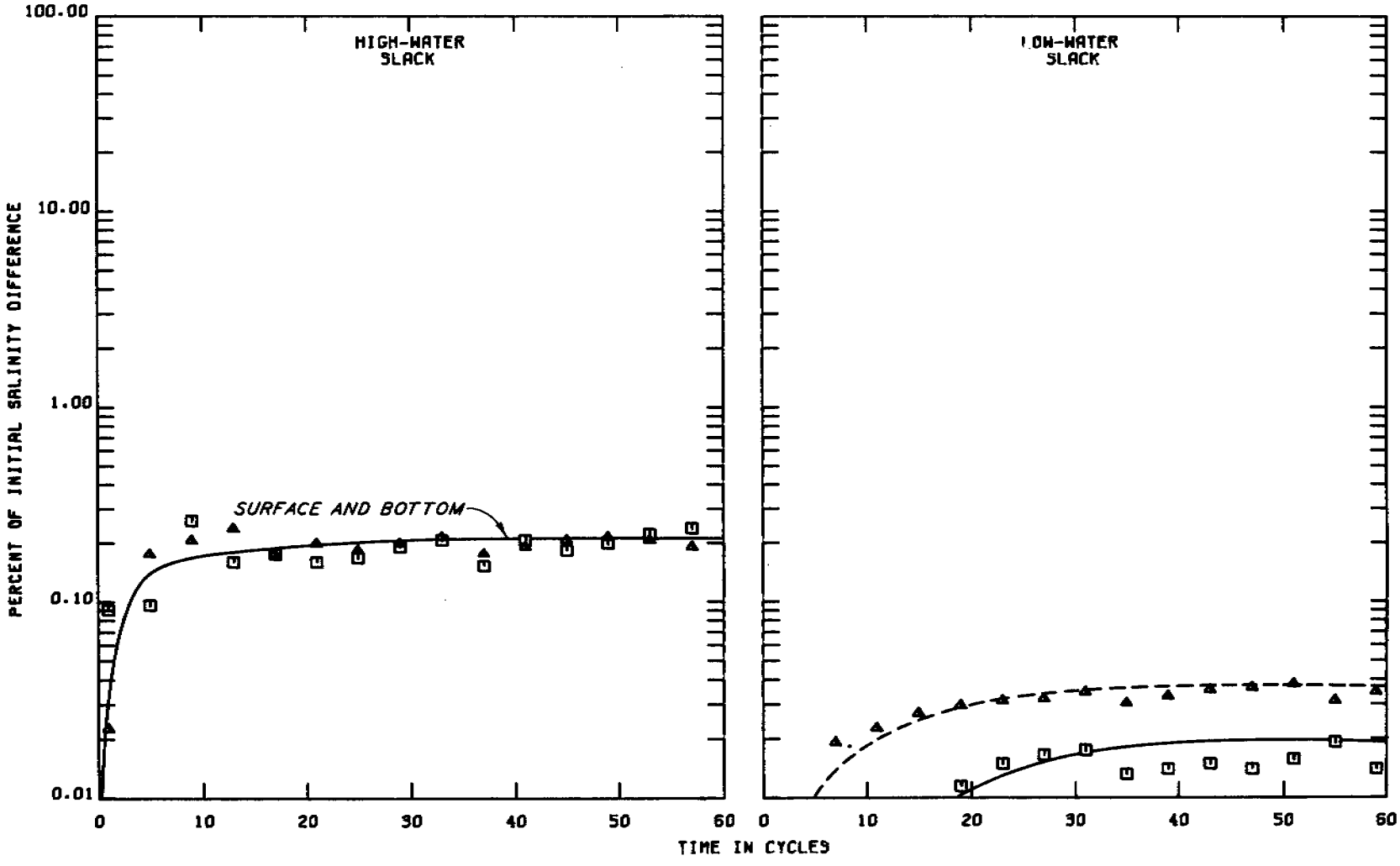
BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION III



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ — — — BOTTOM

DELAWARE RIVER MODEL

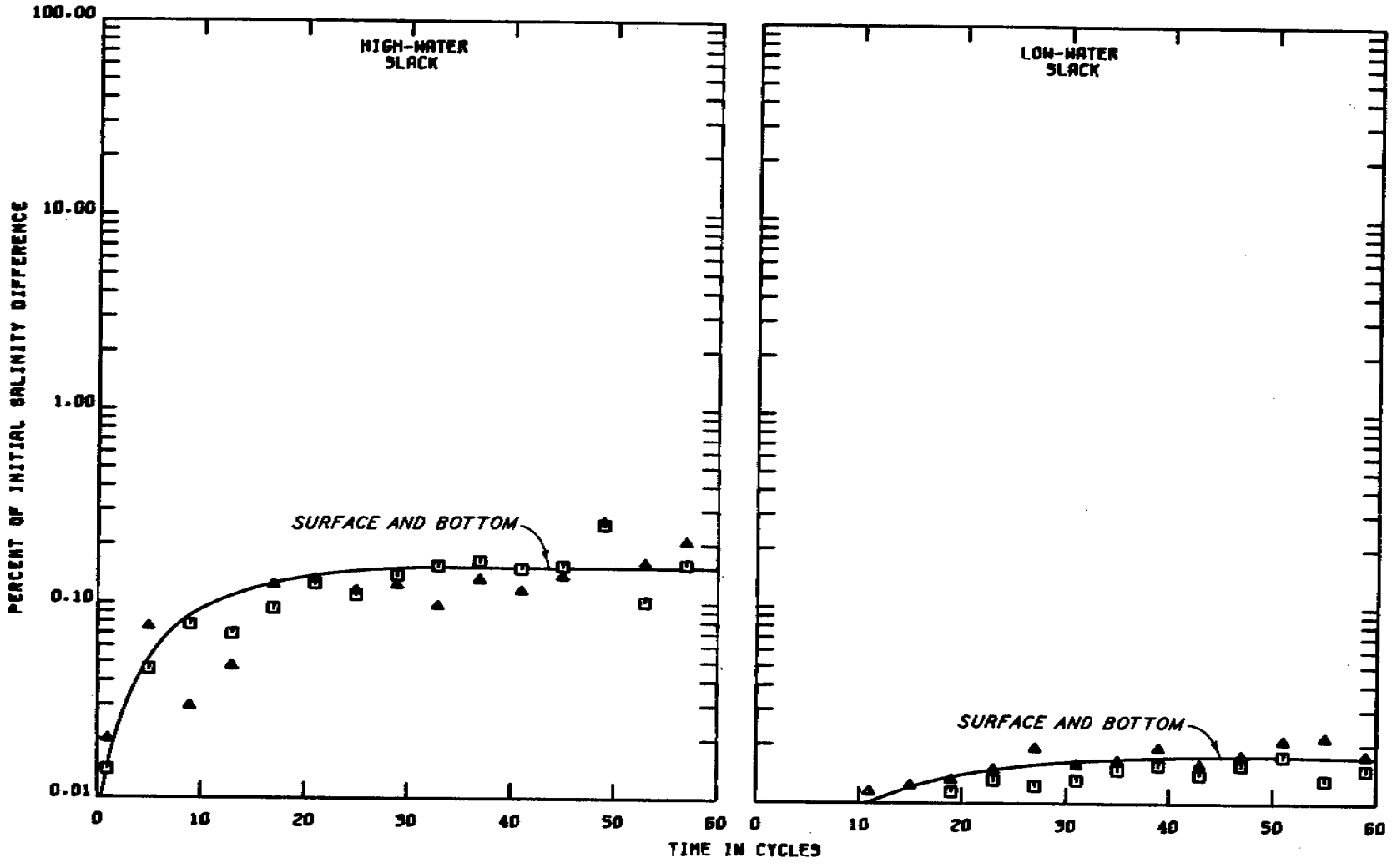
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION U2

PLATE 147

PLATE 148



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

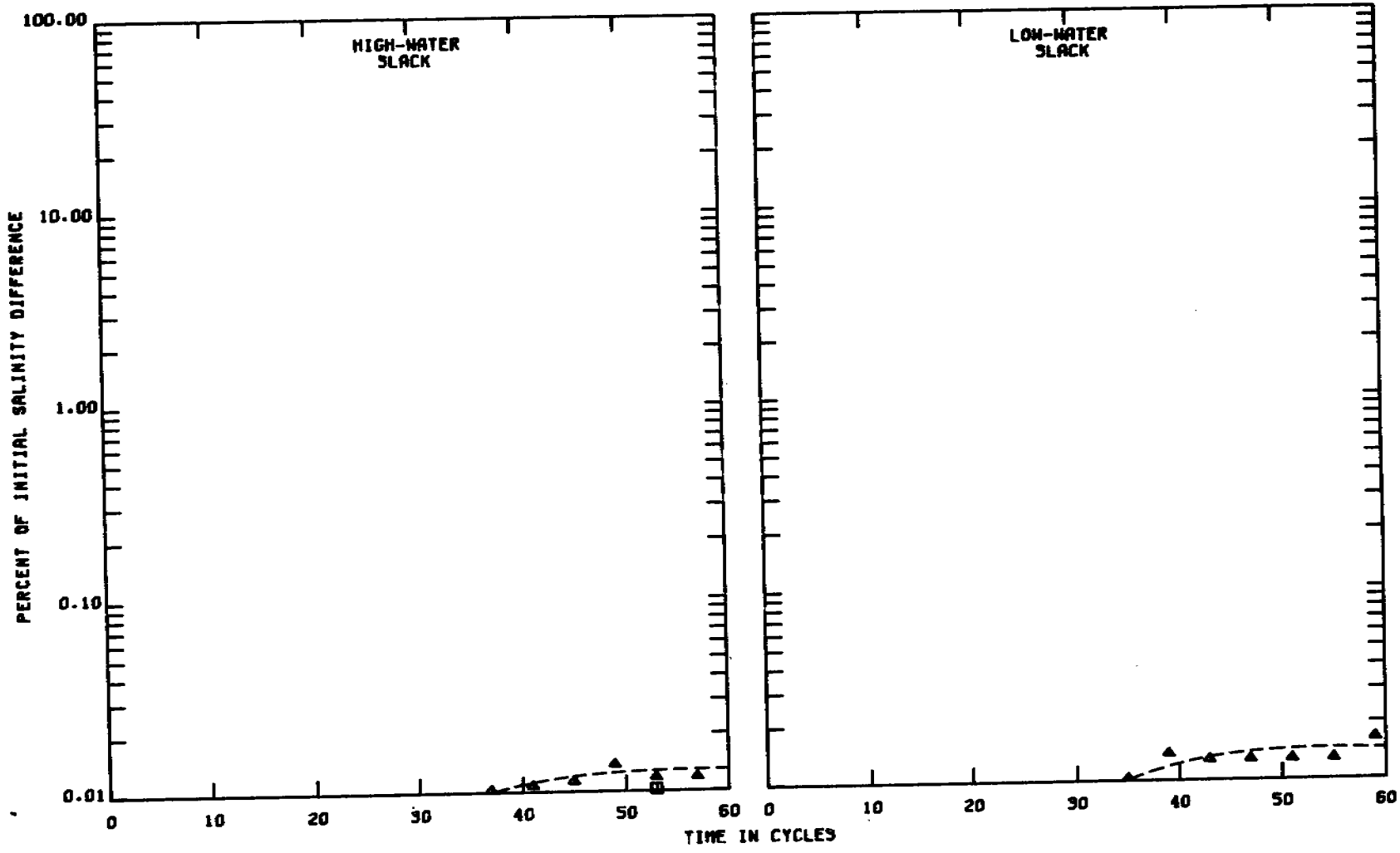
▲ - - - BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION U3



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

⊡ ——— SURFACE

▲ - - - BOTTOM

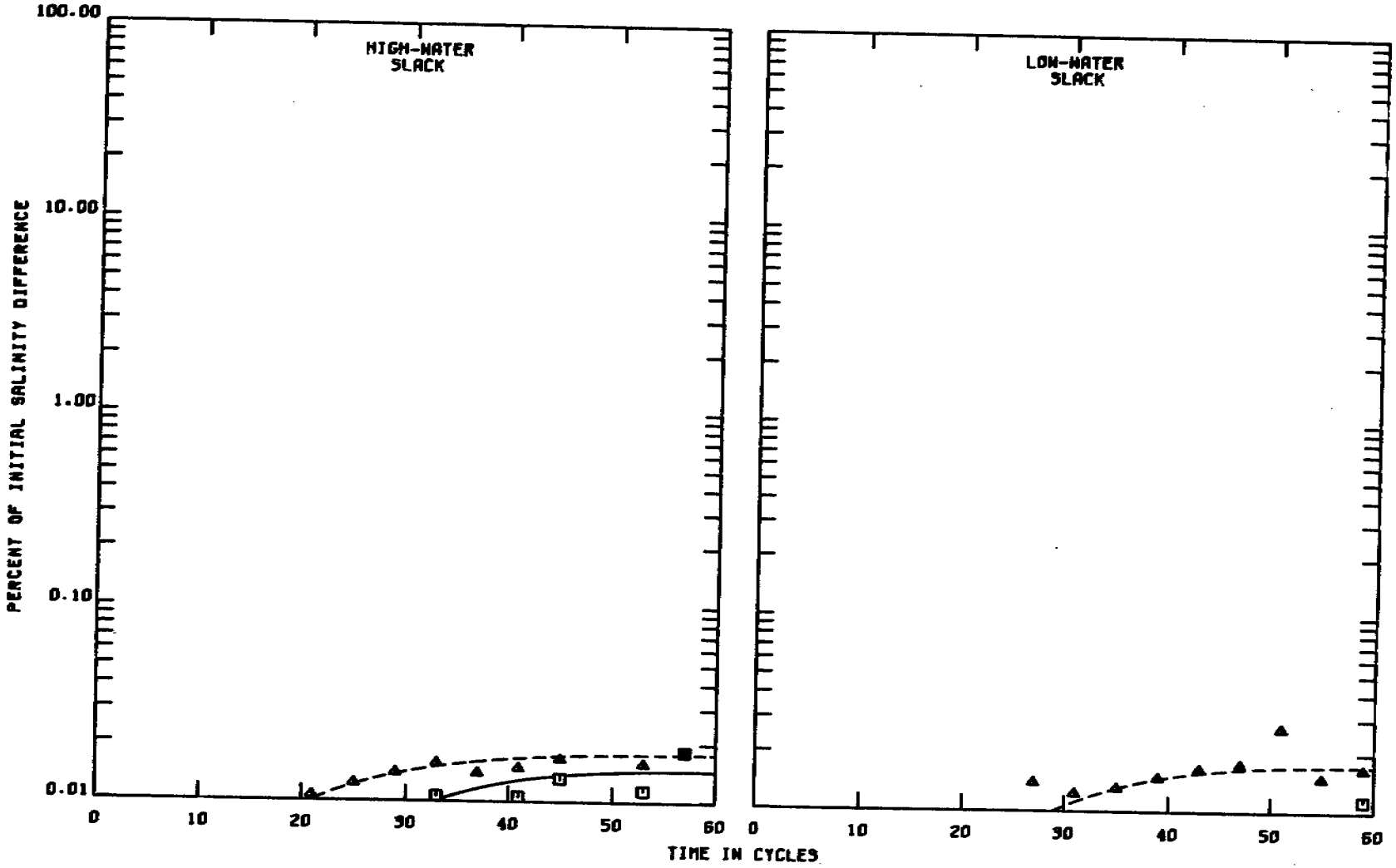
DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION U4

PLATE 149



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

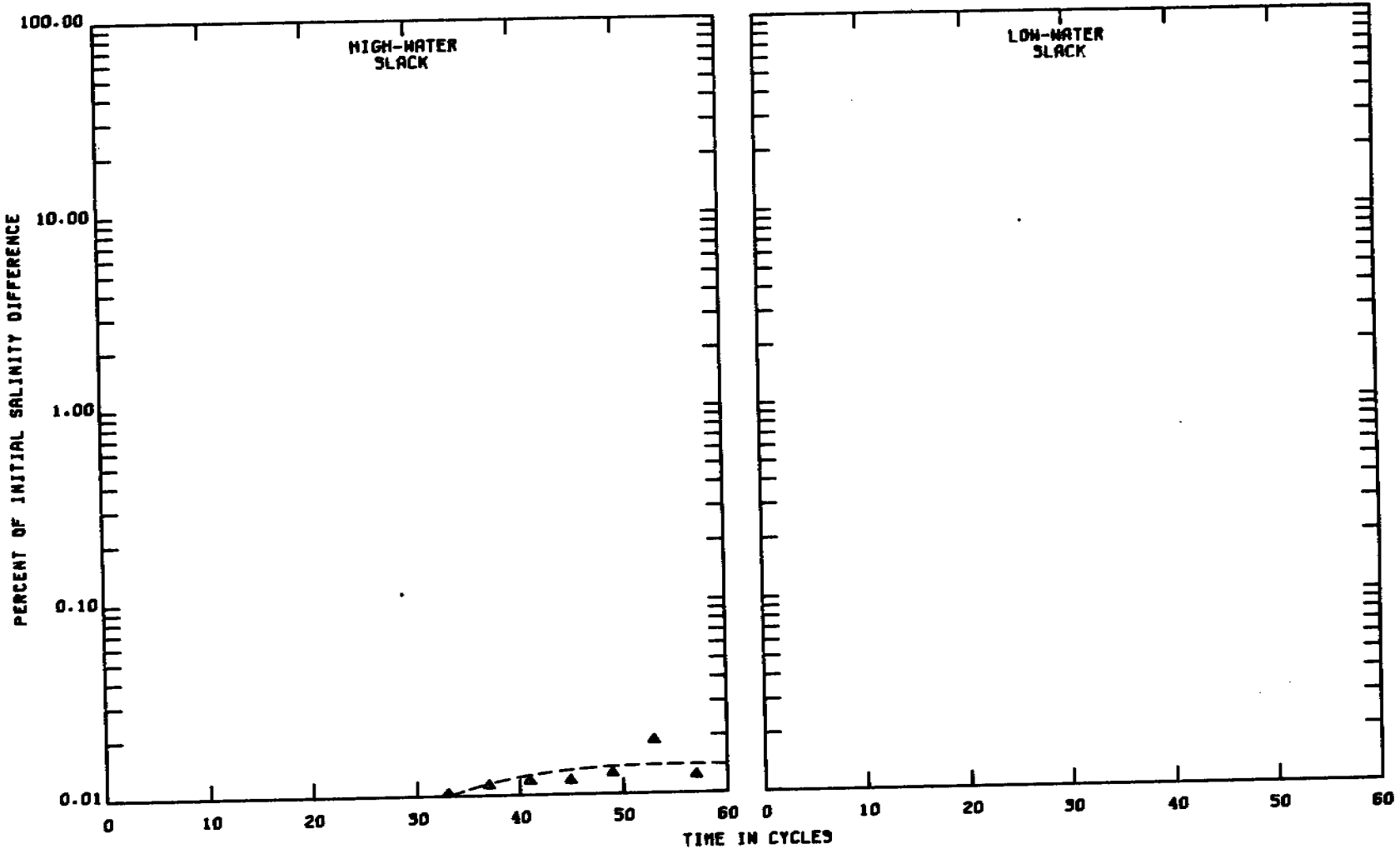
BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION U5



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ - - - BOTTOM

DELAWARE RIVER MODEL

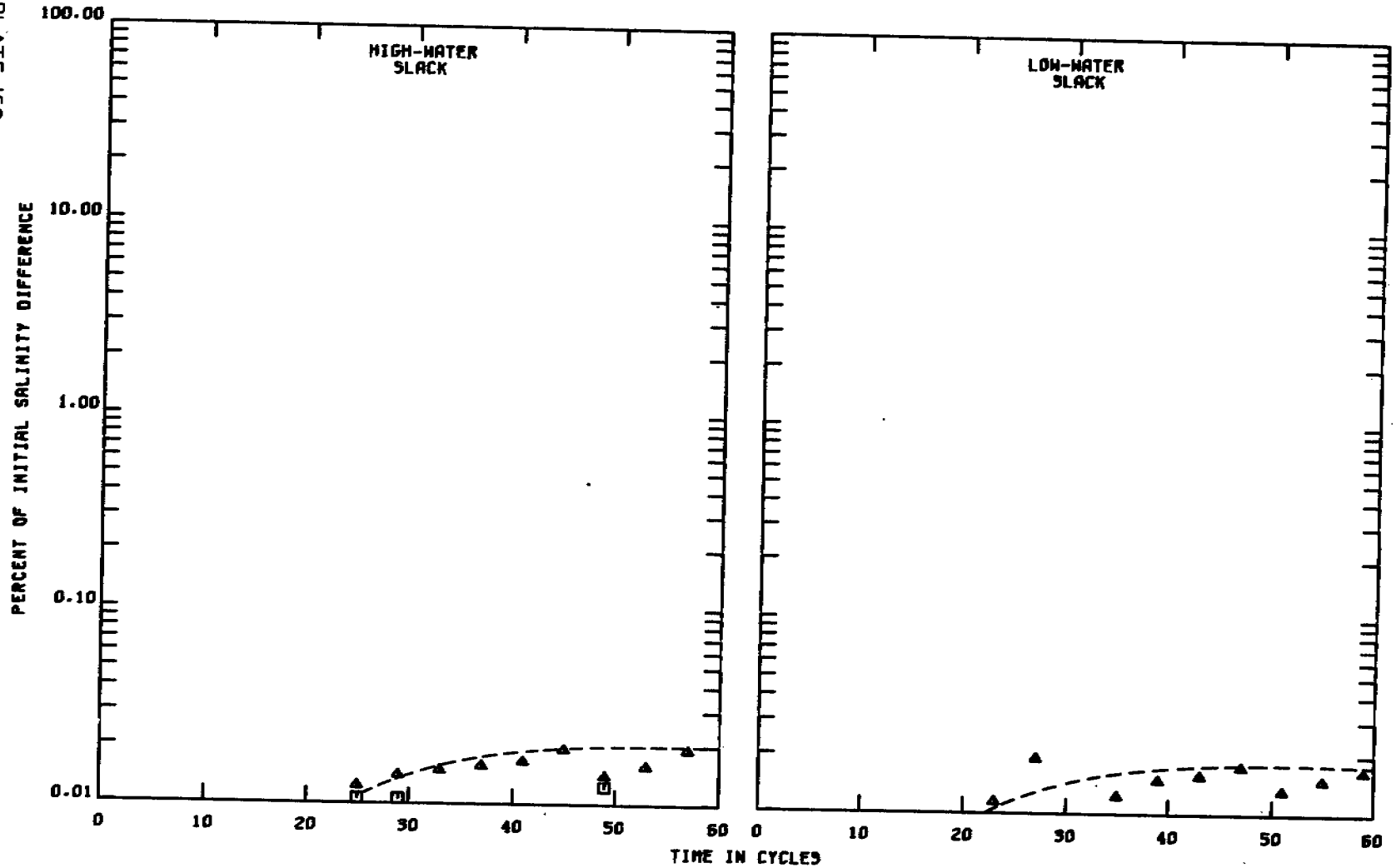
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION U6

PLATE 151

PLATE 152



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

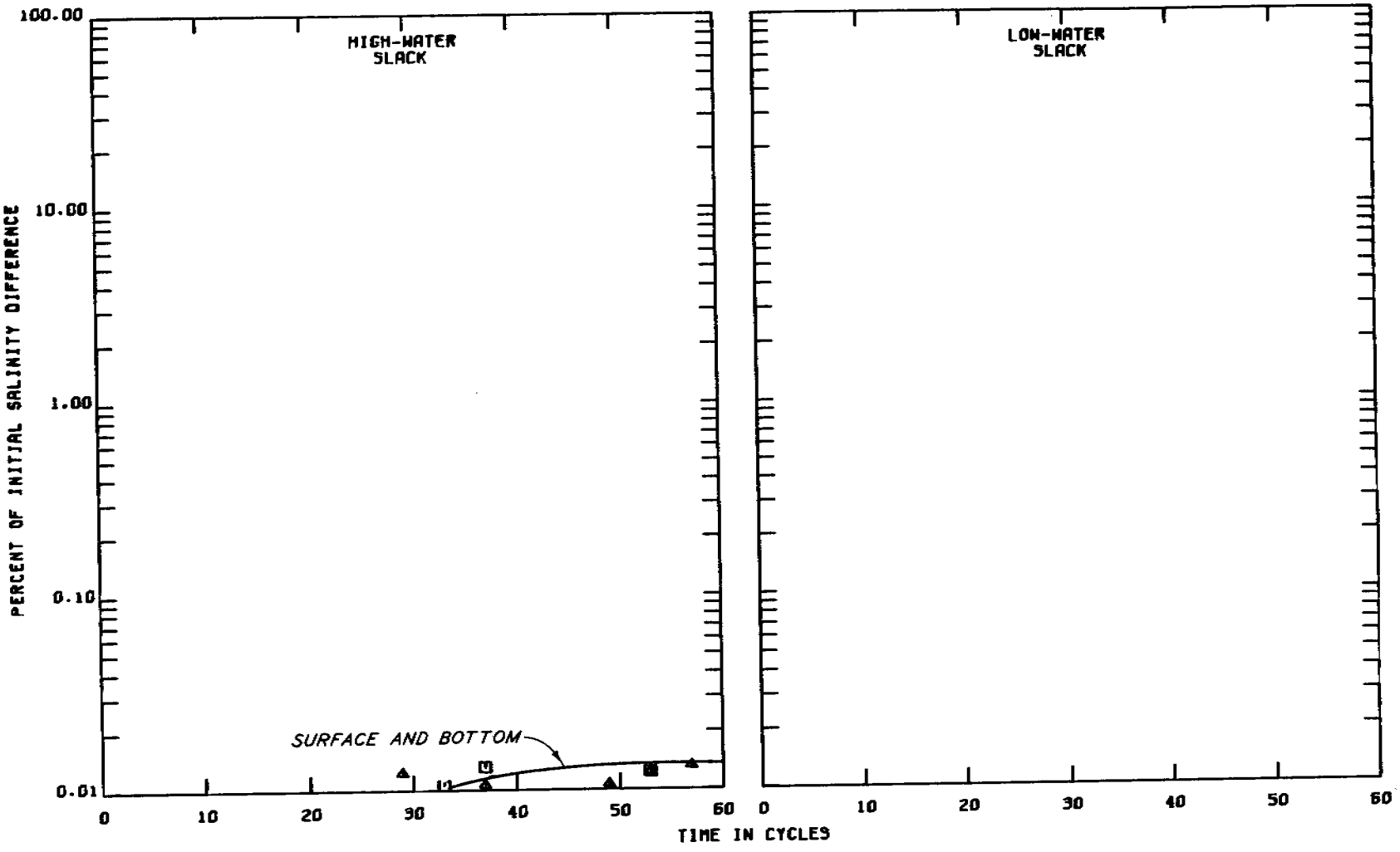
BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION 17



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

BOTTOM

DELAWARE RIVER MODEL

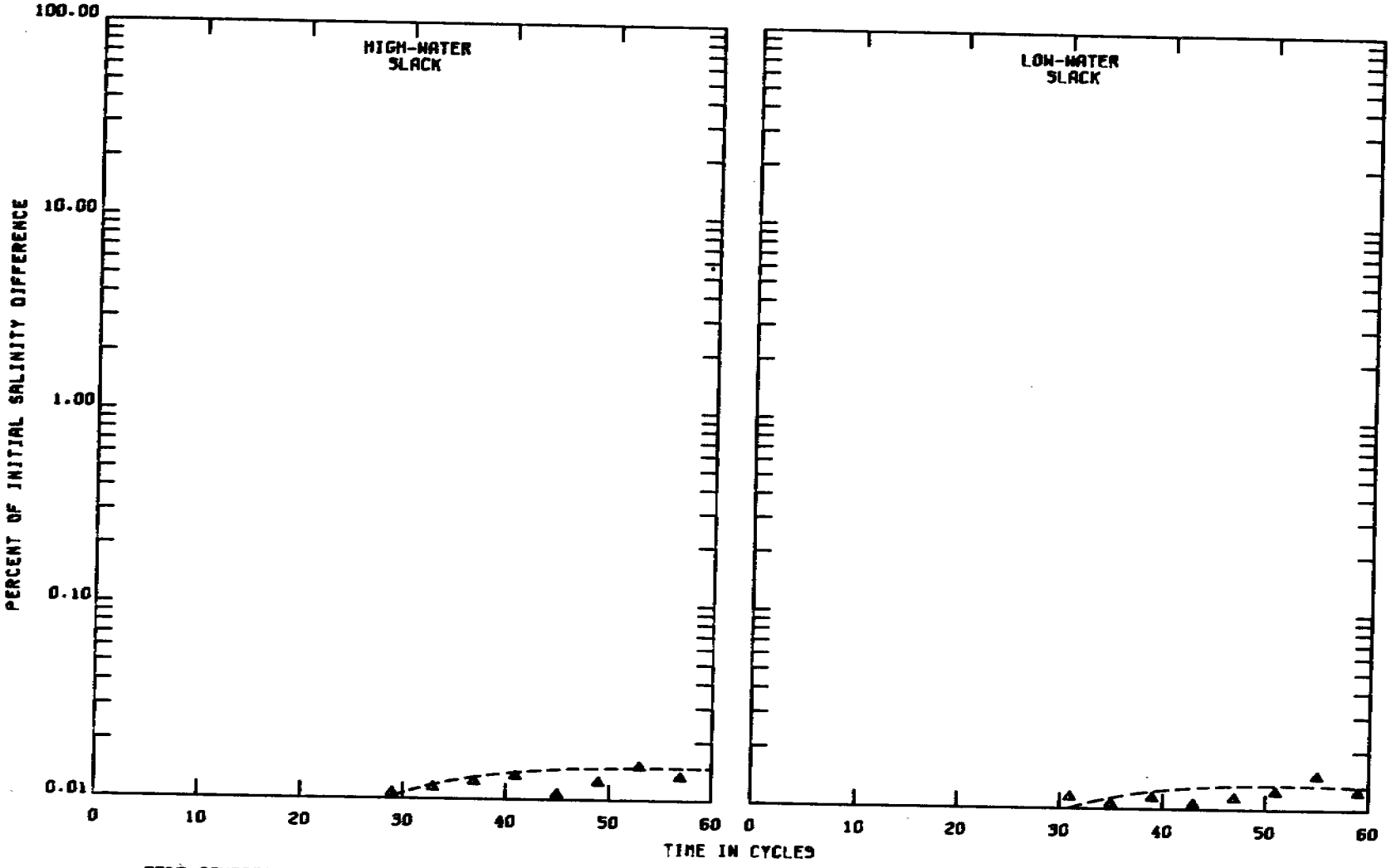
SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION U8

PLATE 153

PLATE 154



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

○ ——— SURFACE

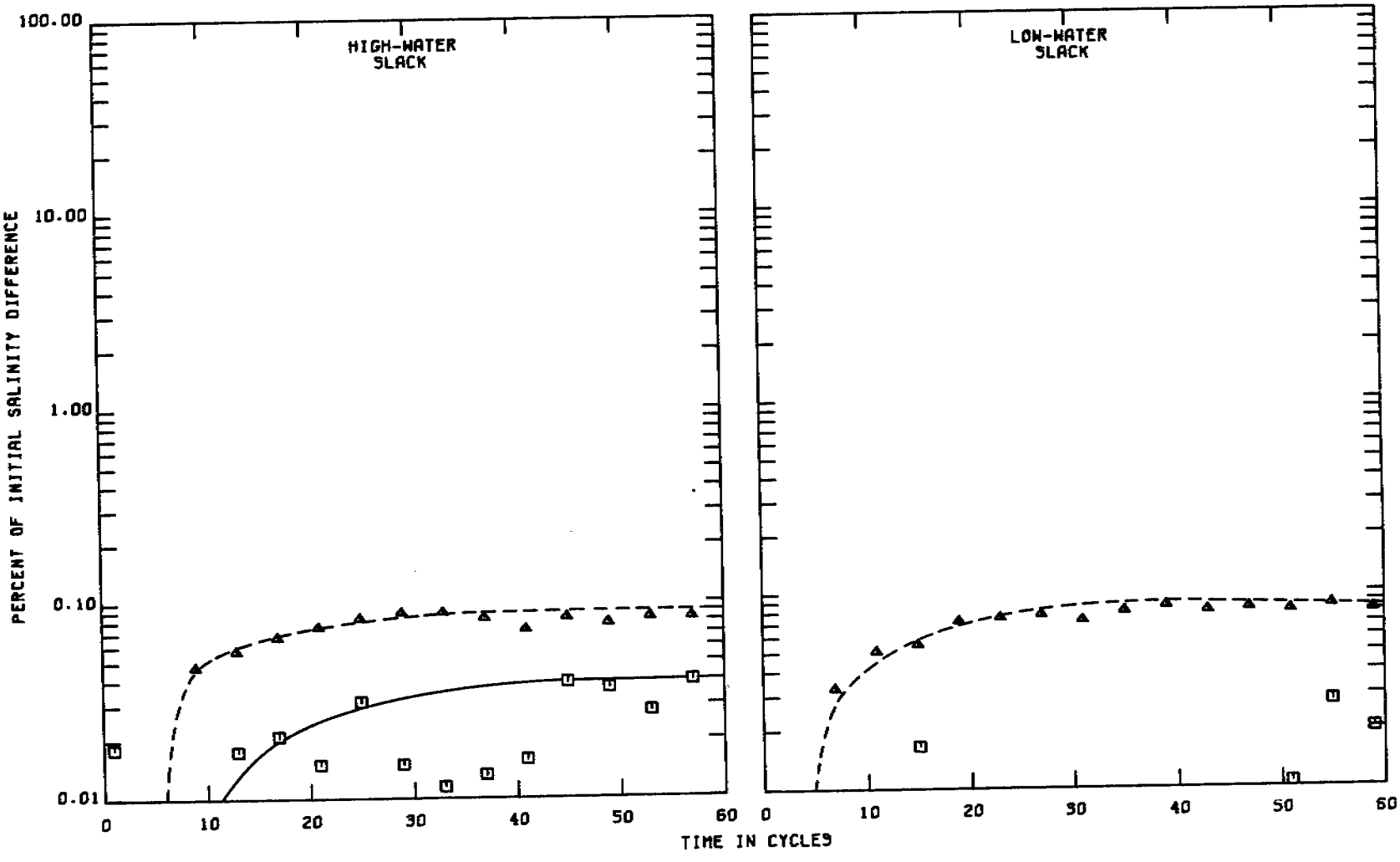
▲ - - - BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION U10



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

△ – – – BOTTOM

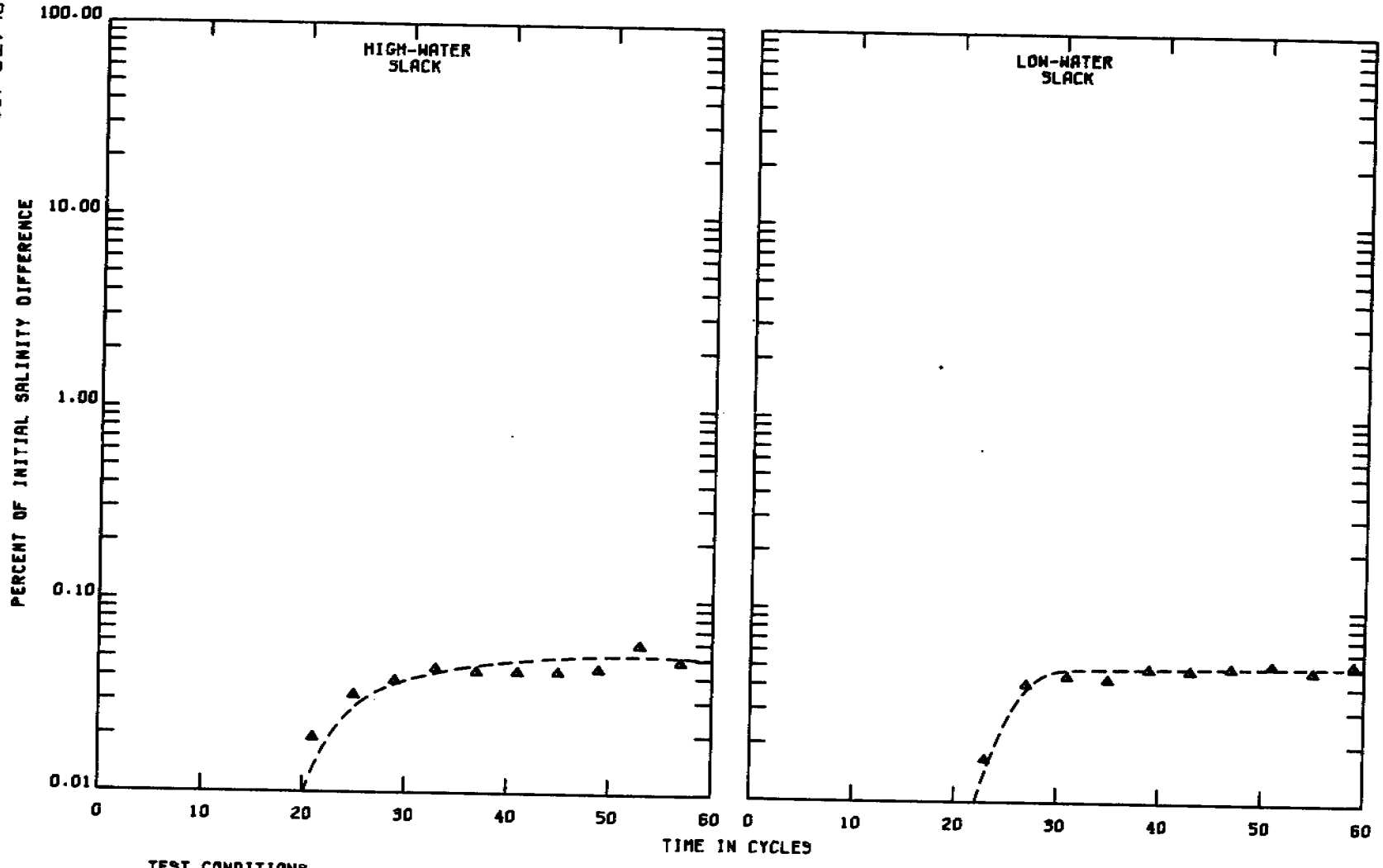
DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION CR1

PLATE 155



TEST CONDITIONS

FRESH-WATER DISCHARGE	20200 CFS
BASE SALINITY AT DIFFUSER	17.6 PPT
EFFLUENT SALINITY	29.0 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

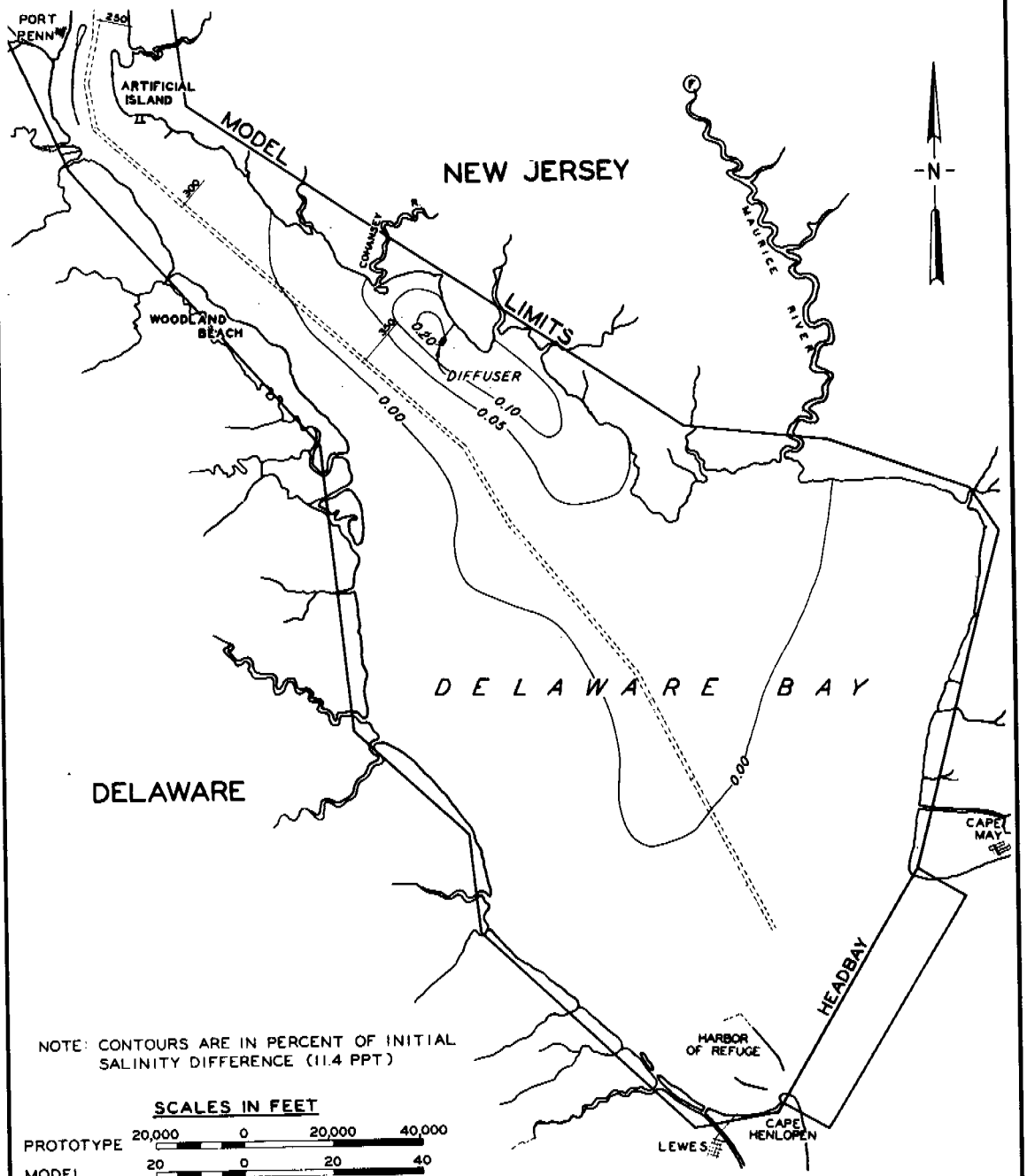
△ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-MEAN FLOW PERIOD

STATION CR2



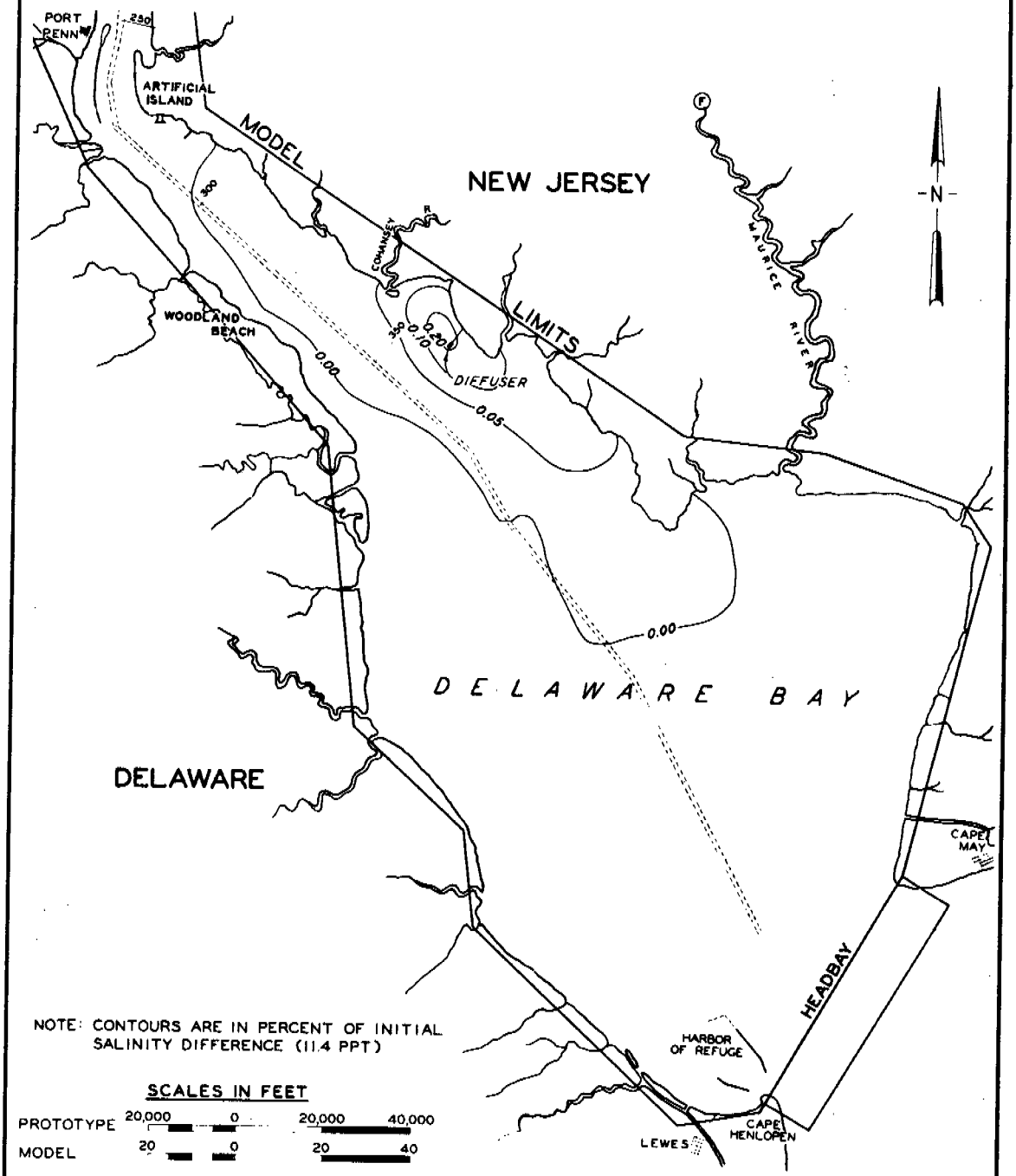
DELAWARE RIVER MODEL

EFFLUENT DISPERSION PATTERNS

LOCAL HIGH-WATER SLACK
SURFACE DEPTH - CYCLE 60

MEAN-FLOW PERIOD

PLATE 157



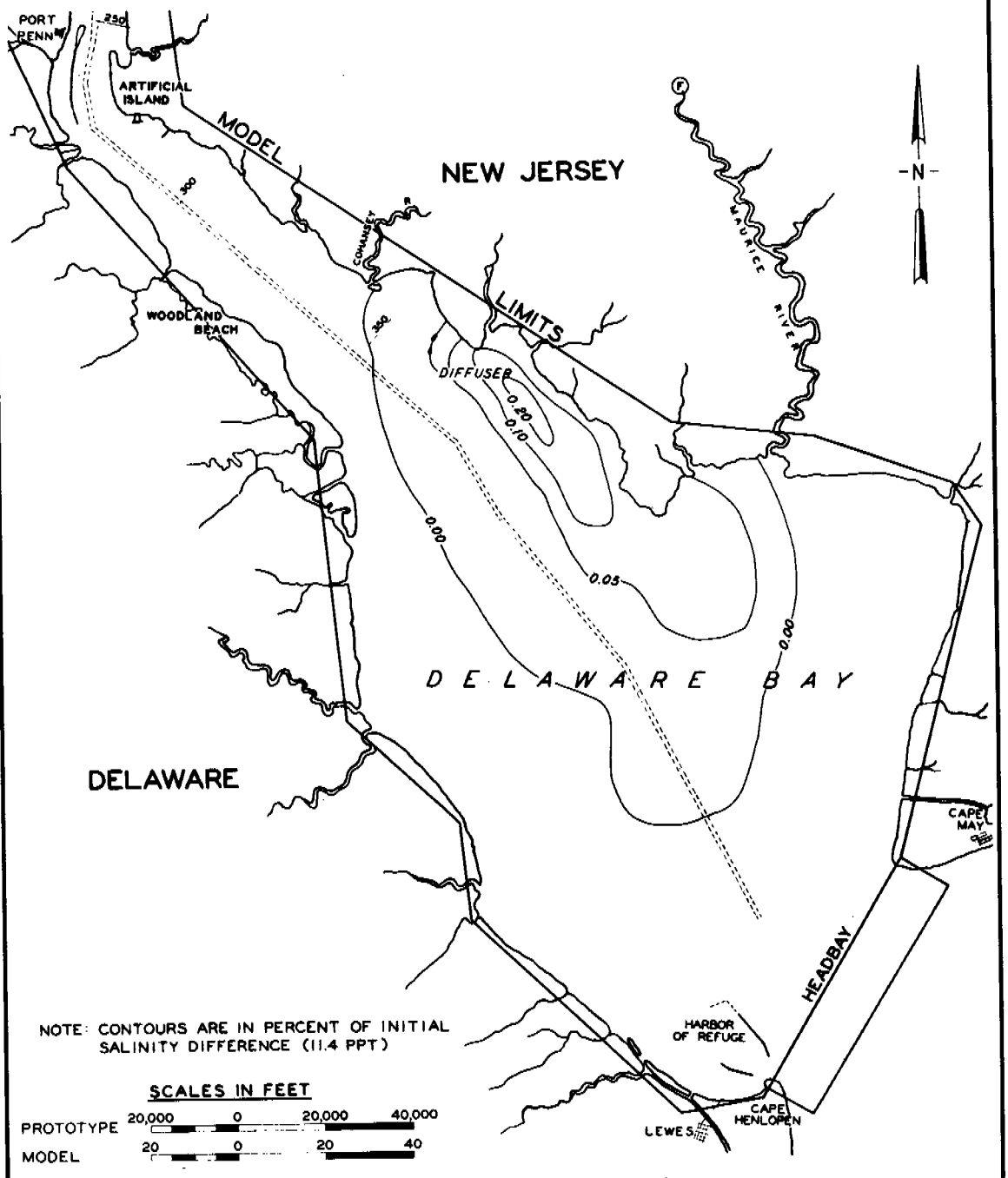
DELAWARE RIVER MODEL

EFFLUENT DISPERSION PATTERNS

LOCAL HIGH-WATER SLACK
BOTTOM DEPTH - CYCLE 60

MEAN-FLOW PERIOD

PLATE 158



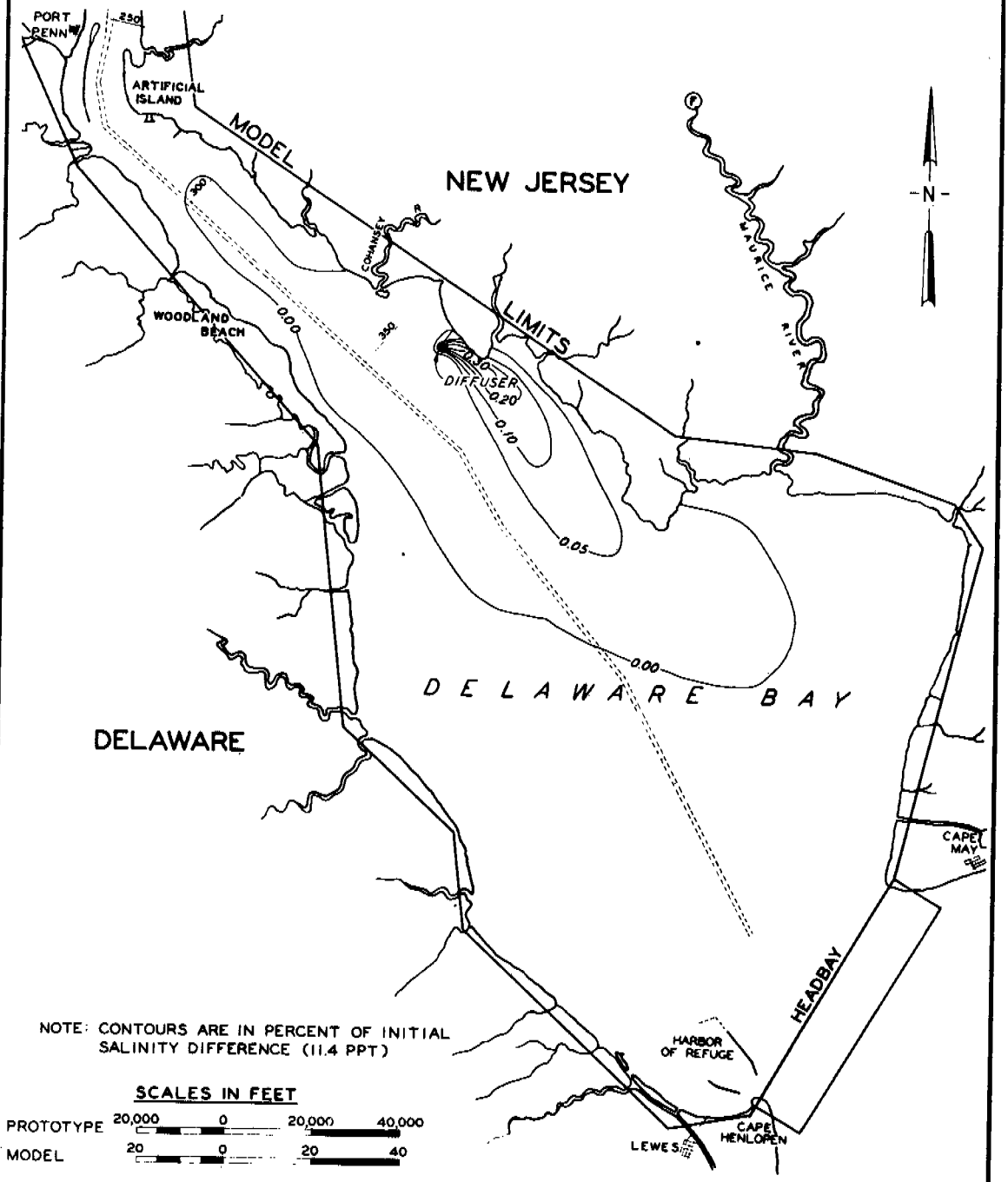
DELAWARE RIVER MODEL

EFFLUENT DISPERSION PATTERNS

LOCAL LOW-WATER SLACK
SURFACE DEPTH - CYCLE 60

MEAN-FLOW PERIOD

PLATE 159



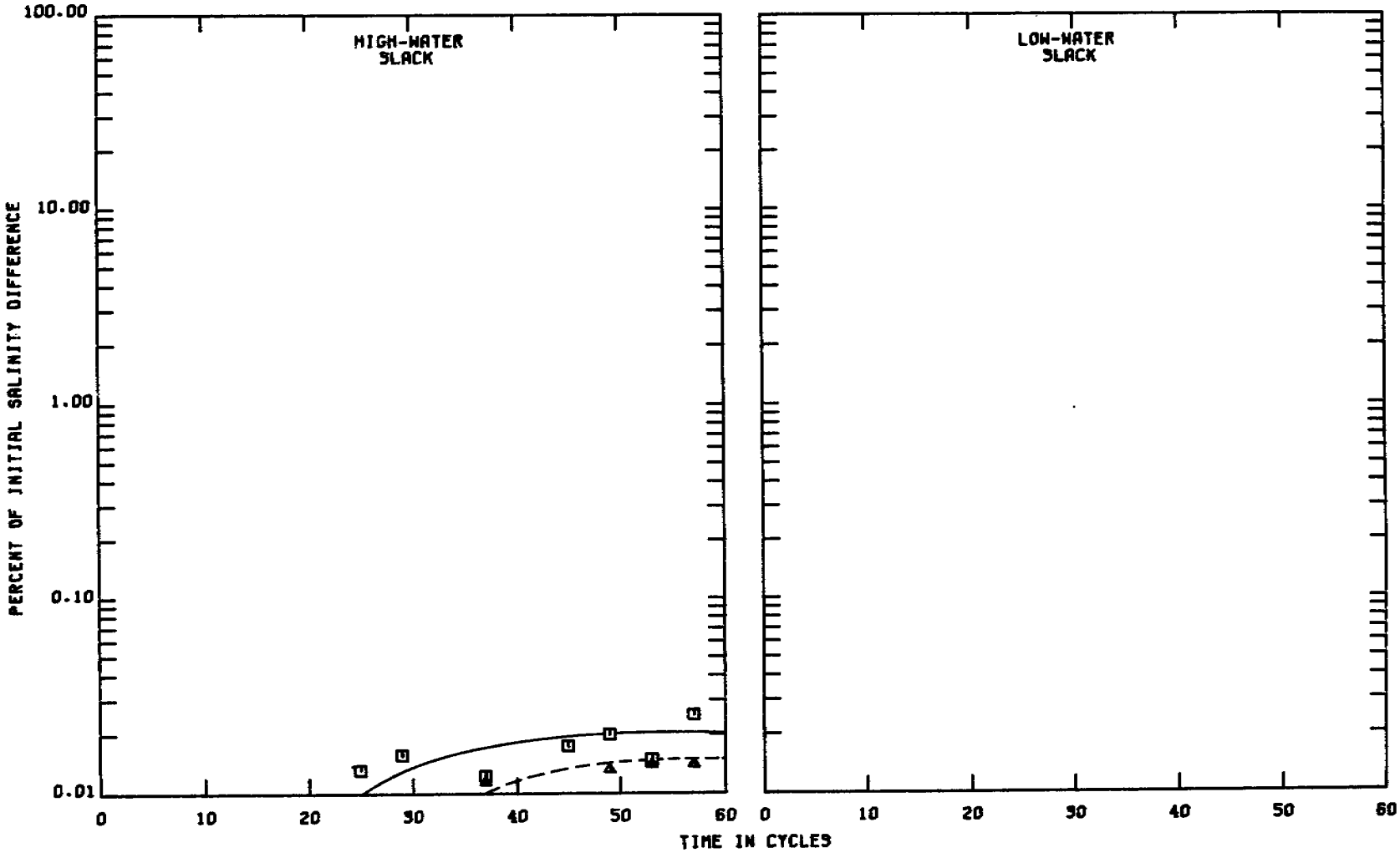
DELAWARE RIVER MODEL

EFFLUENT DISPERSION PATTERNS

LOCAL LOW-WATER SLACK
BOTTOM DEPTH - CYCLE 60

MEAN-FLOW PERIOD

PLATE 160



TEST CONDITIONS

FRESH-WATER DISCHARGE	60800 CFS
BASE SALINITY AT DIFFUSER	11.0 PPT
EFFLUENT SALINITY	22.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

▲ — — — BOTTOM

DELAWARE RIVER MODEL

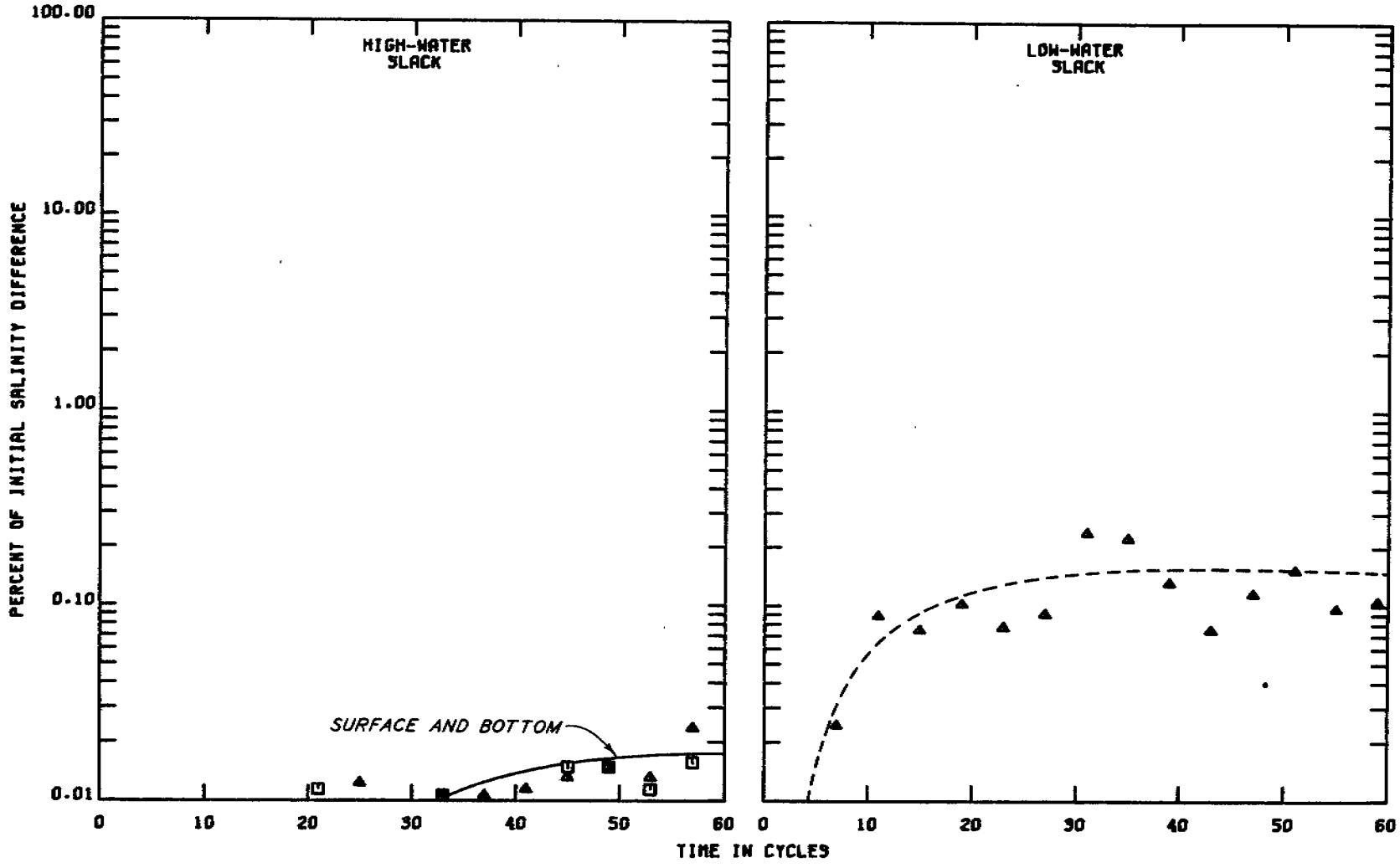
SALINE WATER DISPERSION TEST

10MGD PLANT-HIGH FLOW PERIOD

STATION DI

PLATE 161

PLATE 162



TEST CONDITIONS

FRESH-WATER DISCHARGE	60600 CFS
BASE SALINITY AT DIFFUSER	11.0 PPT
EFFLUENT SALINITY	22.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

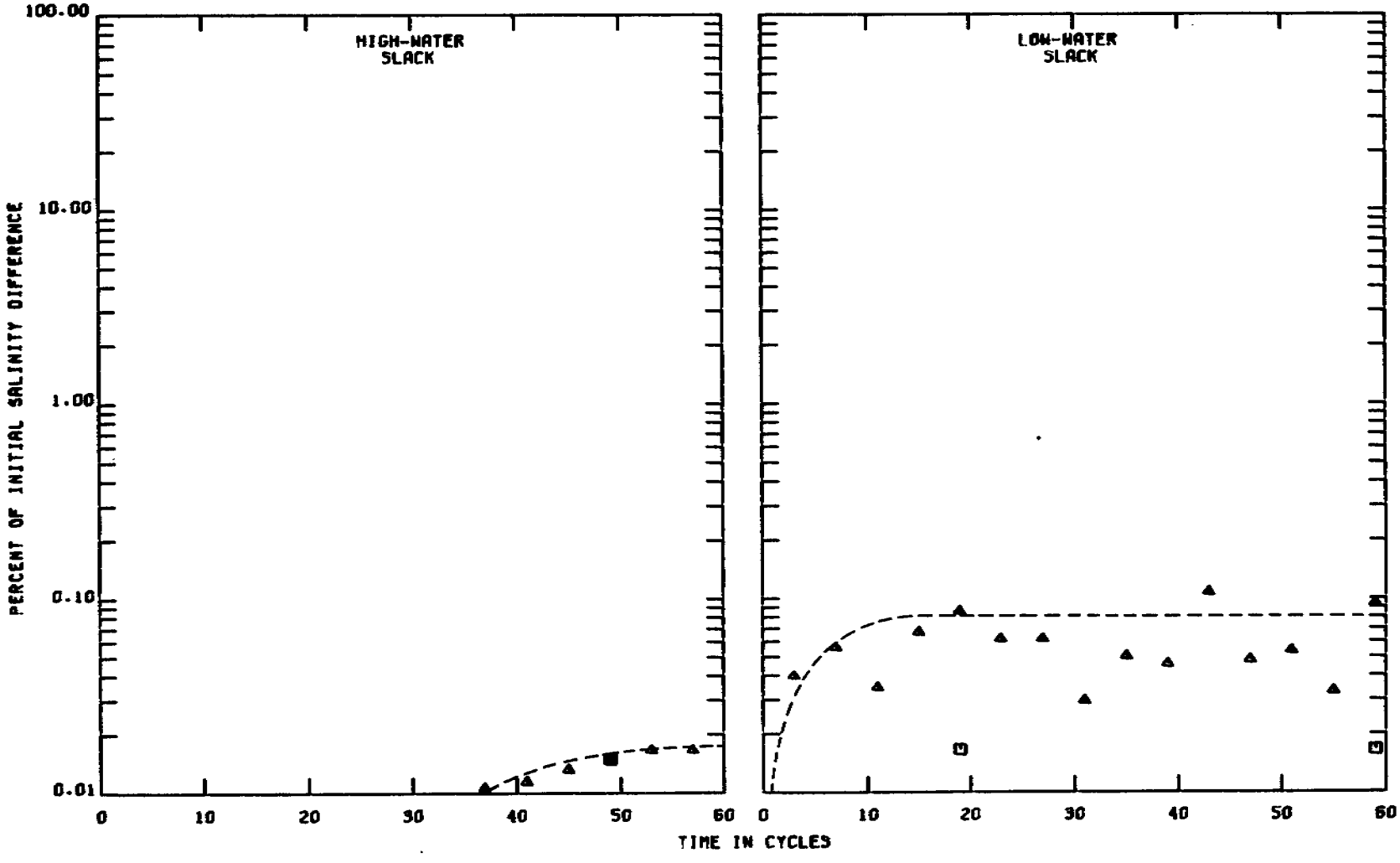
▲ - - - BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-HIGH FLOW PERIOD

STATION D2



TEST CONDITIONS

FRESH-WATER DISCHARGE	60600 CFS
BASE SALINITY AT DIFFUSER	11.0 PPT
EFFLUENT SALINITY	22.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

SURFACE

BOTTOM

DELAWARE RIVER MODEL

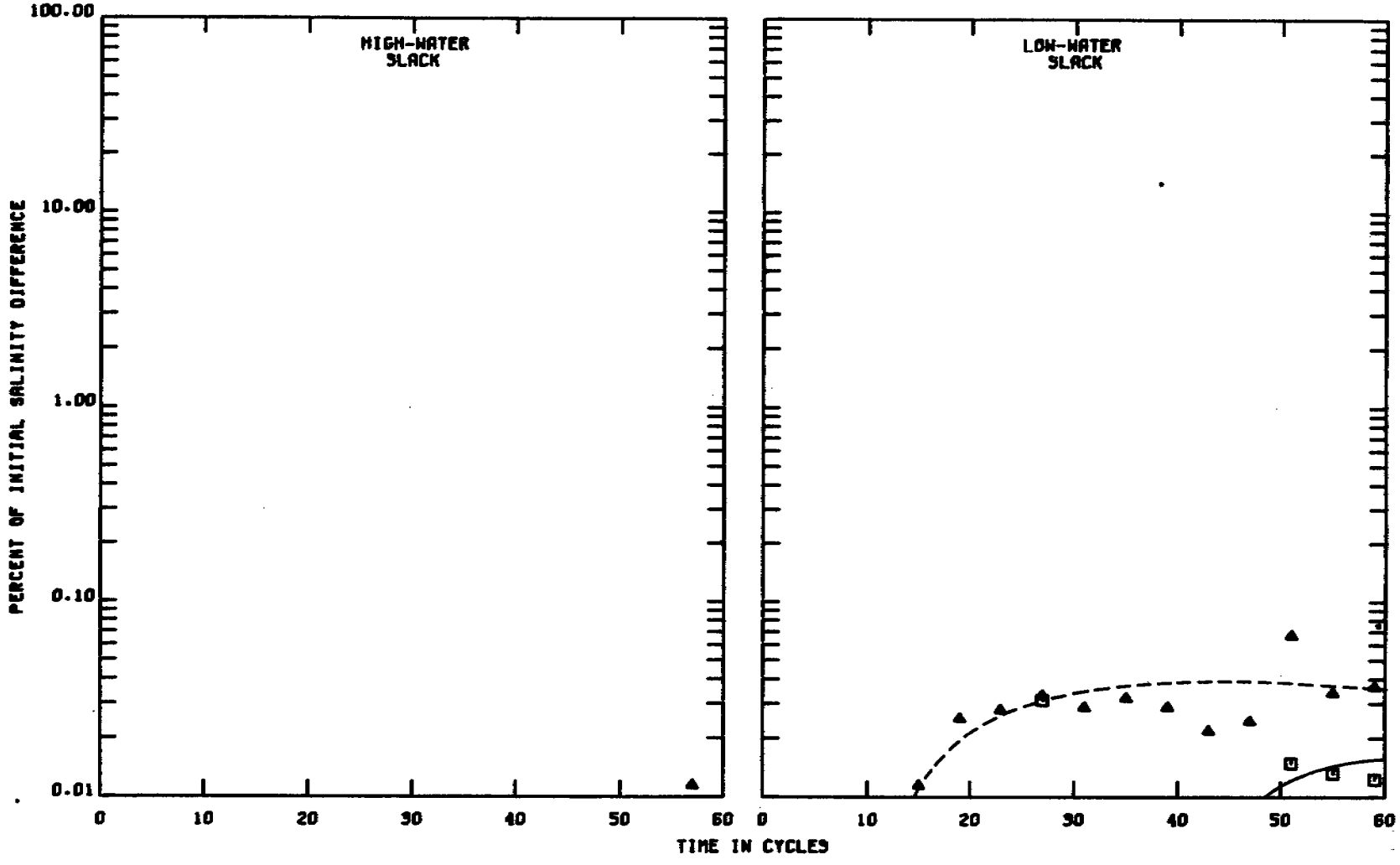
SALINE WATER DISPERSION TEST

10MGD PLANT-HIGH FLOW PERIOD

STATION D3

PLATE 163

PLATE 164



TEST CONDITIONS

FRESH-WATER DISCHARGE	60600 CFS
BASE SALINITY AT DIFFUSER	11.0 PPT
EFFLUENT SALINITY	22.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

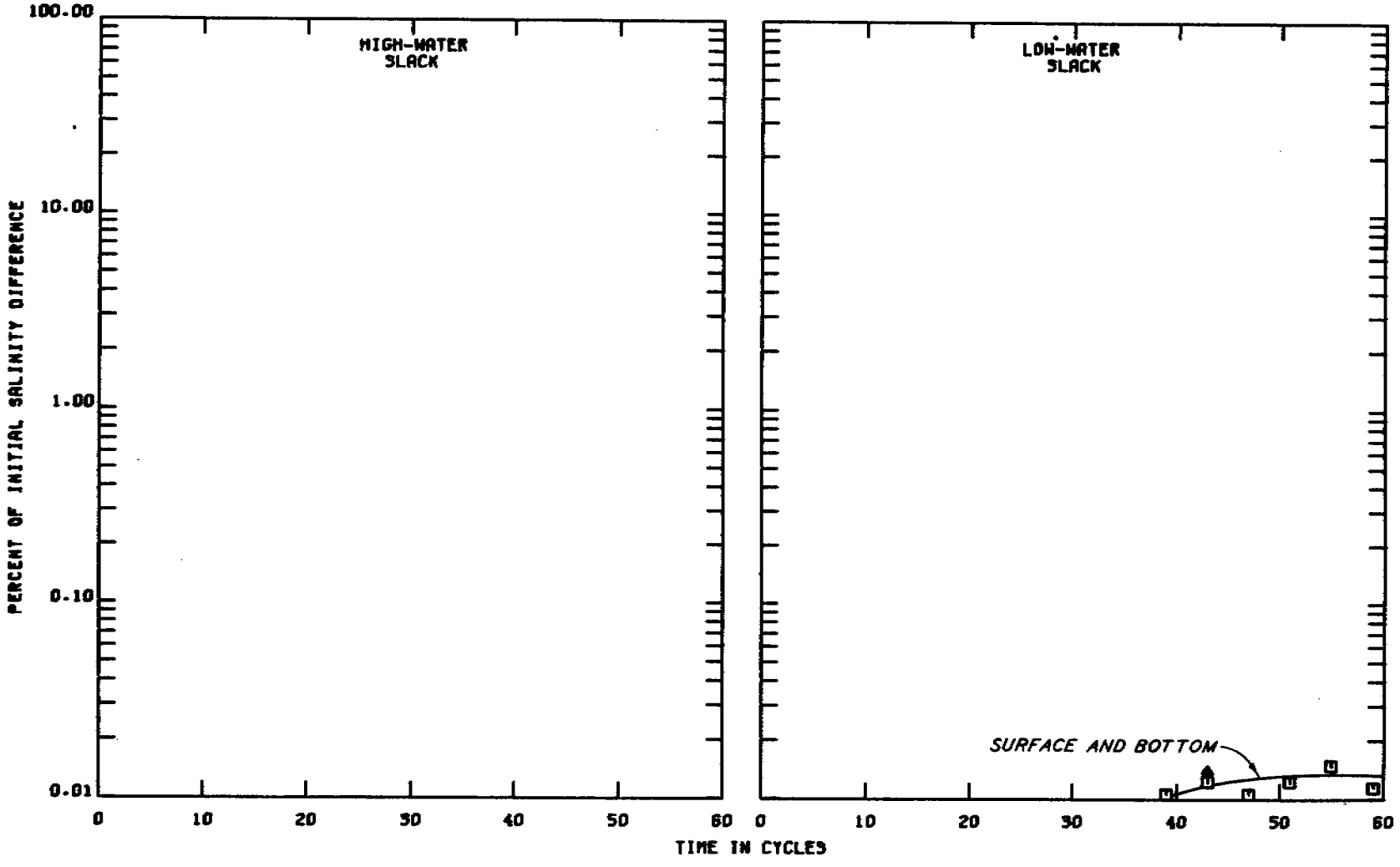
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-HIGH FLOW PERIOD

STATION D7



TEST CONDITIONS

FRESH-WATER DISCHARGE	60600 CFS
BASE SALINITY AT DIFFUSER	11.0 PPT
EFFLUENT SALINITY	22.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ —— SURFACE

▲ – – – BOTTOM

DELAWARE RIVER MODEL

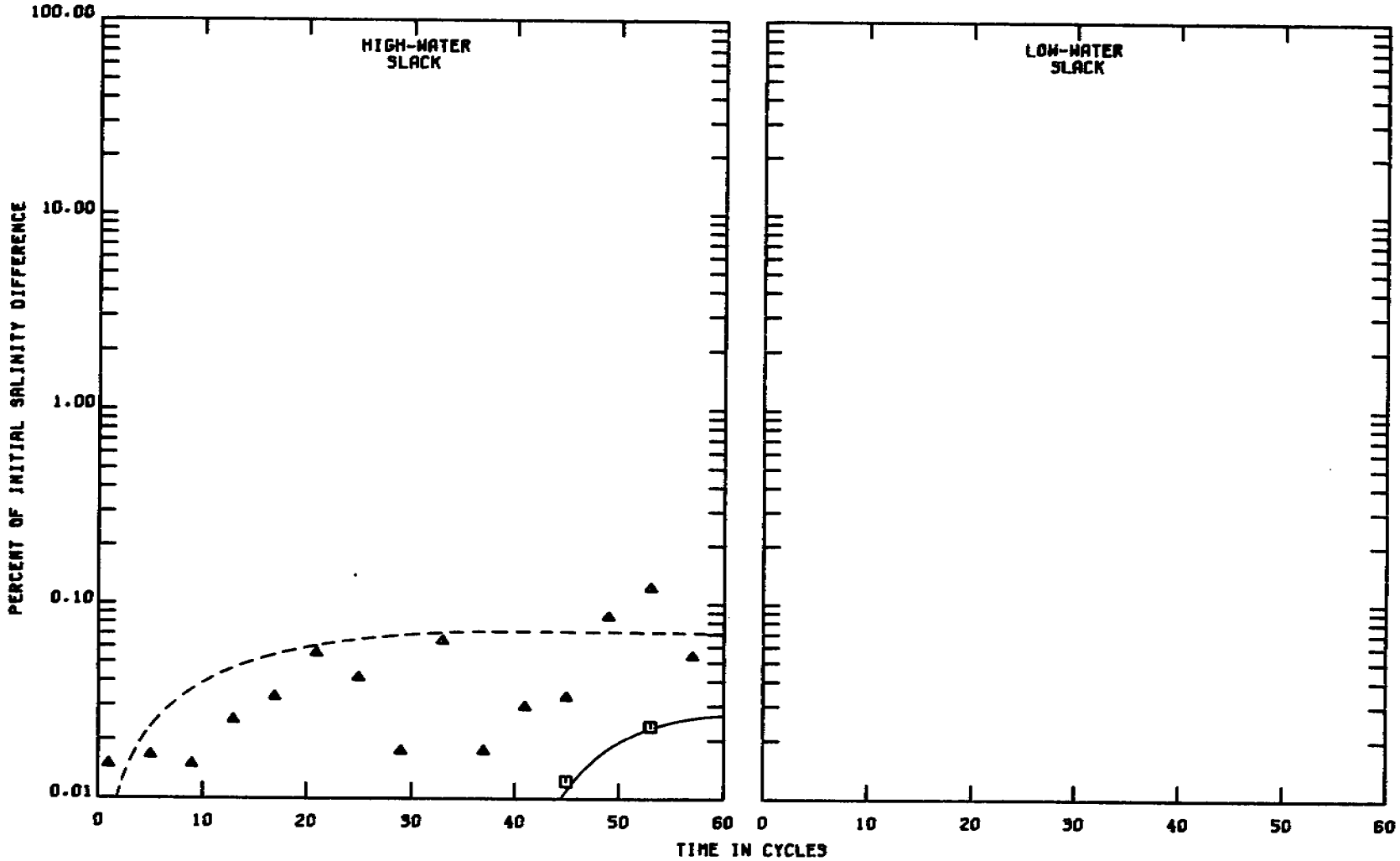
SALINE WATER DISPERSION TEST

10MGD PLANT-HIGH FLOW PERIOD

STATION D11

PLATE 165

PLATE 166



TEST CONDITIONS

FRESH-WATER DISCHARGE	60600 CFS
BASE SALINITY AT DIFFUSER	11.0 PPT
EFFLUENT SALINITY	22.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

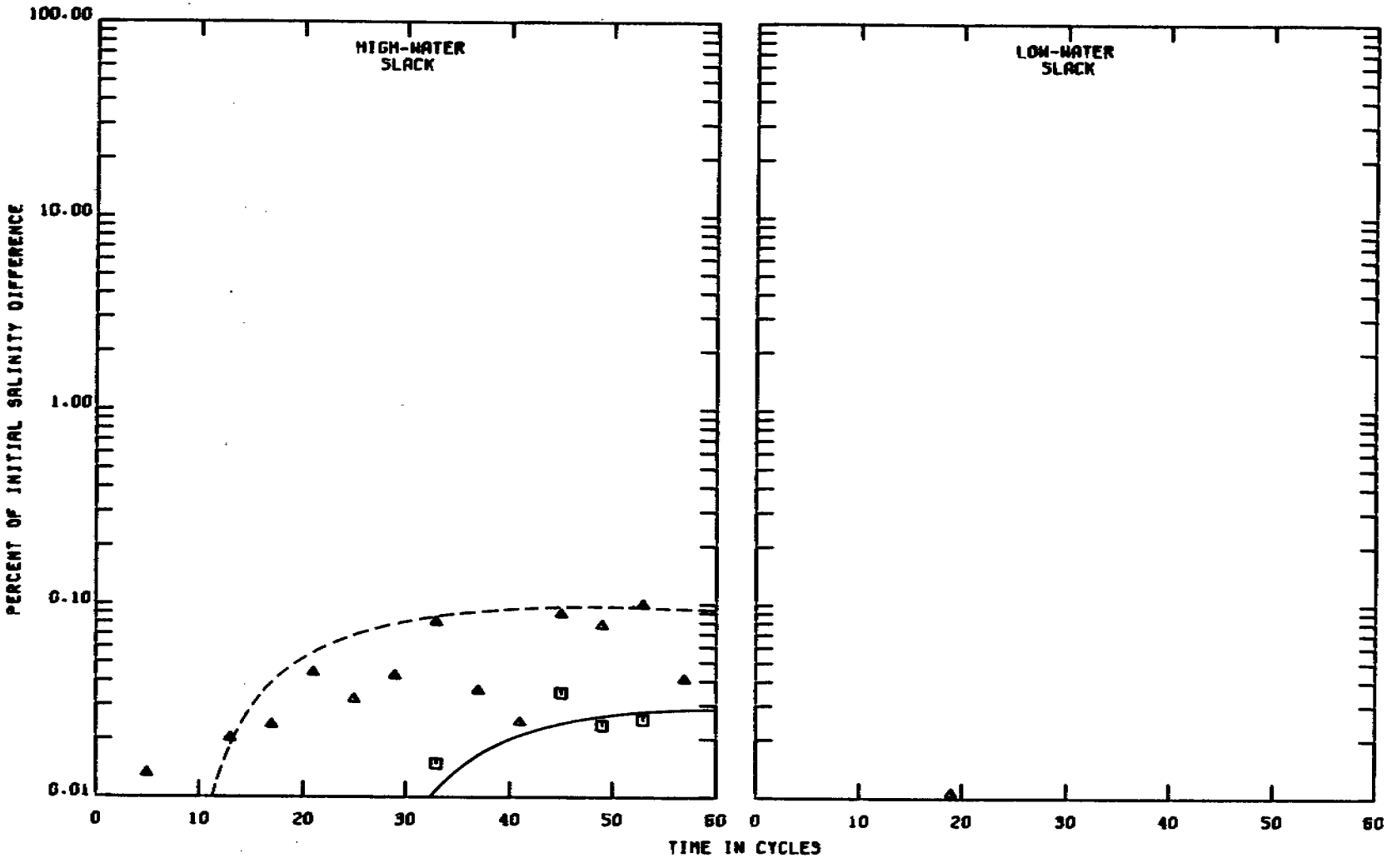
▲ - - - BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-HIGH FLOW PERIOD

STATION U1



TEST CONDITIONS

FRESH-WATER DISCHARGE	60600 CFS
BASE SALINITY AT DIFFUSER	11.0 PPT
EFFLUENT SALINITY	22.4 PPT
INITIAL SALINITY DIFFERENCE	11.4 PPT
EFFLUENT INJECTION RATE	21.2 MGD

LEGEND

□ ——— SURFACE

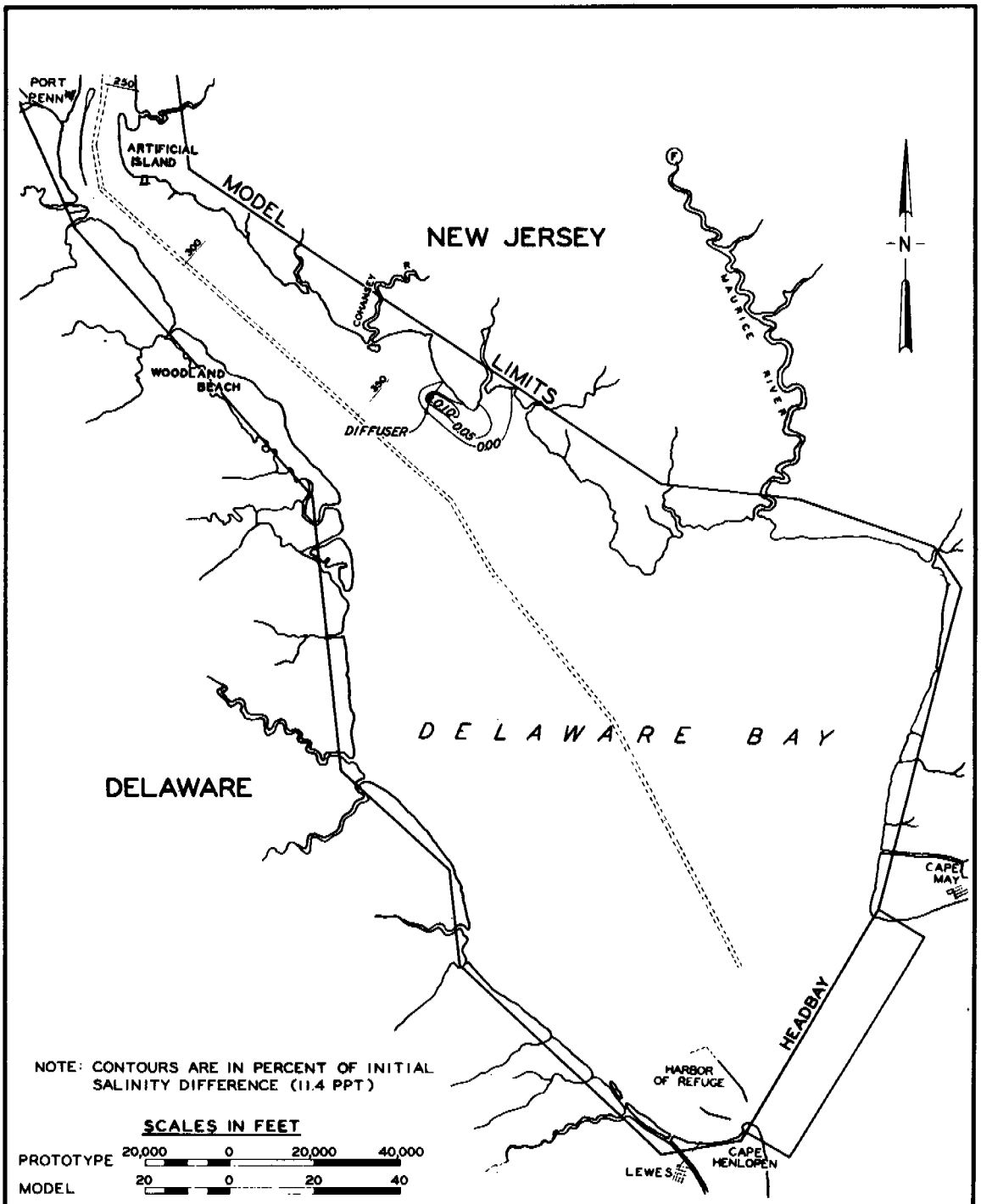
▲ – – – BOTTOM

DELAWARE RIVER MODEL

SALINE WATER DISPERSION TEST

10MGD PLANT-HIGH FLOW PERIOD

STATION U2



DELAWARE RIVER MODEL

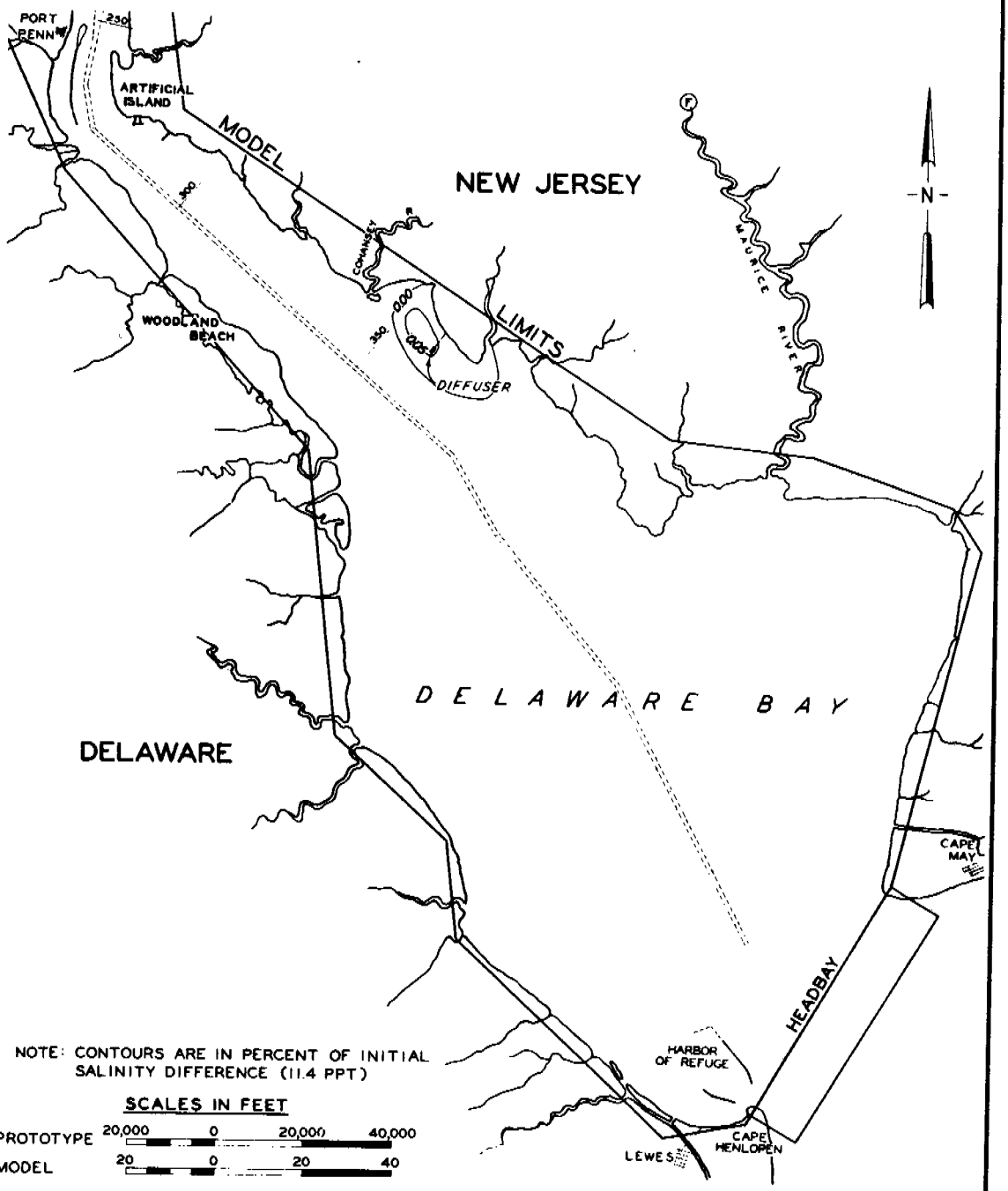
EFFLUENT DISPERSION PATTERNS

LOCAL LOW-WATER SLACK

BOTTOM DEPTH - CYCLE 60

HIGH-FLOW PERIOD

PLATE 168



DELAWARE RIVER MODEL

EFFLUENT DISPERSION PATTERNS

LOCAL HIGH-WATER SLACK
BOTTOM DEPTH - CYCLE 60

HIGH-FLOW PERIOD

PLATE 169

☆ U. S. GOVERNMENT PRINTING OFFICE : 1971 O - 449-654